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Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. XLVI. No. 1.

DESCRIPTIONS OF BOLCA FISHES.

By C. R. Eastman.

With Two Plates.

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No. 1. *Descriptions of Bolca Fishes.* By C. R. Eastman.

There are two principal sources of information in regard to the marine fish fauna of the Eocene period, leaving out of account the minor evidence that is presented by detached hard parts, such as teeth and other fragmentary remains. The first of these, which is at the same time the most important and historically the most interesting, is that furnished by the tolerably abundant skeletons occurring in the fissile limestone of Monte Bolca and Monte Postale in northern Italy. The other is that association of ichthyic remains which is known from the nearly equivalent horizon of the London Clay.

These two faunas fortunately supplement each other to a considerable extent, one of them making us acquainted with the large variety of forms which flourished during the later Eocene, and the other supplying us with important anatomical details. For the conditions of preservation in clay beds are obviously very different from those which are peculiar to limestone. Calcareous sediments are more compact; and where pressure and subsequent hardening occur, bodies which are not absolutely rigid, like the skeletons of vertebrates, or even the outer covering of chelonians and crocodilians, are liable to become compressed and flattened out. Hence, as a general rule, the parts belonging to either side of the body in fishes become squeezed together and confused when preserved in limestone, and the pliant head-bones become more or less distorted and displaced. This is almost invariably the case with the fishes from Monte Bolca, and for a correct understanding of the cranial osteology we must turn to the uncrushed skulls from Sheppey and elsewhere.

The London Clay fauna,[1] however, is not nearly so rich as the Italian, either in point of numbers or variety; and it is accordingly the latter which provides us with the principal data for comparing the ichthyic representation of Eocene and modern times. Comparisons of this nature and of detailed structural modifications are of the very greatest importance, since by their means we are able to trace the direction and

[1] Agassiz, L., Report on the Fossil Fishes of the London Clay (Rept. Brit. Assoc. Adv. Sci. pp. 279–310, 1845).

extent of variation and specialization that has been going on in certain groups during this interval. But the most striking fact which arrests our attention is not that variation should have advanced at such a slow rate since Eocene times as it apparently did, but that this process should have been quickened by such a sudden and enormous acceleration as took place at the dawn of the Tertiary system. Cretaceous forms pass away, leaving only here and there a few moribund survivors (*e. g. Pycnodus, Palaeobalistum*, etc.) in the Eocene, their place being taken by a host of modern types which appear for the most part absolutely unheralded. Not only does the Eocene fish fauna bear an overwhelmingly modern aspect, but many of its types are as highly specialized as they are to-day; and forms which at the present day are widely aberrant have representatives at least as far back as the Middle Eocene. It is evident that an "expression point" (to us Cope's apt term) was reached in the evolution of ichthyic life exactly corresponding to, and contemporaneous with that which is so well recognized in mammalian life, although the cause of the phenomena is in each case unknown.

The literature of Bolca fishes is extensive, and material from the typical locality has become distributed throughout the principal museums of the world. Nevertheless, the authentic specimens which have served either for the establishment of species, or for extending our knowledge in regard to them, are preserved in comparatively few institutions. These are the only reliable standards we have to refer to in cases where the synonymy is confused; and as such cases are numerous, it is of importance to systematists to know where these standards are preserved and may be consulted for study. In the sequel, therefore, a list is given of all the type and figured specimens belonging to the largest single collection of Bolca fishes which at present exists. In the following brief historical summary it is hoped that some facts have been brought together relating to the study of this fauna which shall be of service to investigators.

1. Old Collections, and Early Studies of Bolca Fishes.

Although the priority of the Italian school of geology and palaeontology amongst those of other nations is clearly established, the share contributed by fossil vertebrates towards stimulating inquiry has been less generally appreciated. For this reason it may be profitable to cast a retrospective glance over the formative period of these branches of

natural science, a period coëval with the literary reawakening in Italy. We need not, however, extend our survey so far back as to include the detached statements or speculations of classic authors, or even post-Augustan writers, such as Tertullian and Pomponius Mela, for, familiar as the ancients undoubtedly were with the occurrence of fossils, they do not appear to have been seriously concerned in attempts to account for their origin, nor did their views serve to enlighten subsequent progress. *Per contra*, the doctrines of Aristotle, followed blindly or enlarged upon by scholastic writers during the middle ages, acted as a positive hindrance. Minds which could accept without difficulty Aristotle's ideas of spontaneous generation were free to admit that mineral matter could take on of itself any conceivable shape, even mimicking animate forms. If living plants and animals could produce themselves, why not fossils, as readily? Avicenna,[1] for instance, most brilliant luminary of the Arabian circle of sciences in the tenth century, and whose *Canon Medicinae* remained the principal medical authority throughout the middle ages, proposed a *vis lapidifica*, and following him in the thirteenth century Albertus Magnus[2] affirmed his *virtus formativa*. At a still later period a "World-Spirit," or *Archaeus*, was predicated by Bauhin, and Libavius held that fossils sprang from germs or seeds, like living beings. Glimmerings of a spirit of experiment and observation are rarely in evidence before the fourteenth century. Until about this period nature-study in Europe continued at an extremely low ebb, Greek and Latin scientific works were unread in the original, and untranslated into the vulgar tongue, and popular concepts of natural history were perverted by the bestiaries.

FOURTEENTH CENTURY. In Cecco d'Ascoli (1257–1327),[3] the ill-fated author of *l'Acerba*, and sometime professor of philosophy in the University of Bologna, we discover a man of remarkable erudition and

[1] *Cf.* Wüstenfeld, F., Geschichte der arabischen Aerzte und Naturforscher, nach den Quellen bearbeitet. Göttingen, 1840.

[2] Sighart, J., Albertus Magnus, sein Leben und seine Wissenschaft, nach den Quellen dargestellt. Regensburg, 1857.

[3] Popular name for Francesco Stabili of Ascoli, whom Petrarch honored with a sonnet beginning, —

"Tu se 'l grande Ascolan che il monde allumi."

He has been made the subject within recent years of a thoughtful essay by Welbore St. C. Baddeley, and of a historical romance by Pietro Fanfani (*Cecco d'Ascoli, Racconto storico del secolo XIV*. Leipzic, 1871). *L'Acerba*, which was the immediate cause of the author's death, passed through a score of editions between 1473, the date of the earliest, and 1546. The latest bears date of 1820, at Venice.

varied abilities, in many respects far ahead of his age. The work by which he is best known, an encyclopaedic poem of moderate literary merit, contains a vast number of observations on all manner of things natural and supernatural, in which the veritable and mythical are curiously blended. In Book I., Chapter viii. of *l'Acerba*, which is devoted to thunder, lightning, meteorites, earthquakes, and other physical phenomena, mention is made of the occurrence of fossils, although no definite explanation of their origin is undertaken, as has been claimed by Libri and others. Considering the period in which he wrote, we must admit Cecco to have been a first-rate observer, a good reasoner, and less credulous in his judgments than many of his predecessors and contemporaries. Caustic envy of Dante is conspicuous in various parts of his poem, especially in the concluding passage of Book IV., from which the following lines are taken : —

> " Quì non se canta al modo dele rane,
> Quì non se canta al modo del poeta
> Che finge imaginando cosse vane ;
> Ma quì respiende e luce onne natura,
> Che a chi intende fa la mente lieta ;
> Quì non se regna per la selva oscura."

Less a stranger to fame than Cecco is Giovanni Boccaccio, " prince of story-tellers "(1313–1375), one of whose early amusements consisted in gathering fossil shells near his home in the Valdelsa, hard by Florence. Unusually intelligent and well educated himself, he deplored the prevailing ignorance of his age, and aided largely in reviving the study of classic literature in Italy. Amongst his more serious Latin works is a Geographical Dictionary,[1] a laborious but indiscriminating compilation,

[1] De Montibus, Silvis, Fontibus, etc., supposed to have been written about 1373. The passage on *Elsa fluvius* (q. v.) occurs on p. 456 of the Basle edition, 1589. *Cf.* also, by the same author, *Commento a Dante, Lezione LII*, in Vol. II., pp. 367–369, of the Milan edition, 1863.

On Boccaccio and the extent of his information, the following may be consulted : Hortis, A., Studj sulle opere latine del Boccaccio. Triest, 1879. — Koerting, G., Der Umfang des Wissens Boccaccios, in his Geschichte der Litteratur Italiens, Vol. II. Leipzic, 1880. — Landau, M., Giovanni Boccaccio, sein Leben und seine Werke. Stuttgart, 1877. — Libri, G., Histoire des sciences mathématiques en Italie, Vol. III. Paris, 1840. — A list of the older writers consulted by Boccaccio in the compilation of his *De Montibus*, etc., is published in Boll. Soc. Adriat. Sci. Nat., Ann. III. pp. 62–114.

On Dante as a naturalist, see Holbrook, R. T., Dante and the Animal Kingdom, New York, 1902.

in which he refers to the occurrence of fossils, and agrees with Pomponius Mela (whose *Cosmography* he quotes) in considering them as having belonged to living bodies. A passage is also said to occur in Book VIII. of the *Filocopo*, by the same author, in which fossils are mentioned, and the inference is drawn from them that the land had been submerged beneath the sea; but Brocchi,[1] who is authority for this statement, appears to have been mistaken in his reference.

SIXTEENTH CENTURY. Very few Cinquecentisti appear to have inquired into the significance of fossils. The first to claim our attention is Alexander ab Alexandro (1461–1523), a learned Neapolitan jurisconsult, concerning whom little is known save for personal statements interjected amongst a mass of miscellaneous information in his *Dies Geniales*.[2] In Book V., chapter ix., of this peculiar work, which first appeared at Rome in 1522, the author recalls having seen in the mountains of Calabria, at a considerable distance from the sea, divers sorts of marine shells heaped together and embedded in a variegated hard marble, so that they formed one mass: "*quas quidem ossea et non lapideas esse, et quales in litoralibus radis inspicimus, facile erat cernere*," as he remarks. He refers to the statement of Herodotus[3] concerning the presence of marine shells in the hills of Egypt and over the Libyan desert, from which the Greek geographer had inferred that the sea formerly covered that whole region; and a like explanation is applied by him to Calabria.

According to Brocchi and Lyell, both of whom have furnished excellent accounts of the development of geological science in Italy, Alessandro anticipated by a long interval the theory advanced by Burnet and Whiston in England, which explained the waters formerly covering the land as having been drawn off in consequence of a change in the inclination of the earth's axis of rotation. But such a theory implies an understanding of the Copernican cosmogony, which Alessandro certainly did not possess, and as no such suggestion as is attributed to him can be found in the *Dies Geniales*, the statement is probably an error. Nevertheless, Alessandro is deserving of credit for

[1] Brocchi, G., Discorso sui progressi dello studio della conchiologia fossile in Italia, prefixed to his *Conchiologia Fossile Subappenina*, Vol. I. p. iv. Milan, 1814. Other early references to petrifactions are given by G. Lami in his Hodoeporicon of Chariton and Hippophilus (Deliciae Eruditorum, Vol. X., p. 43, *passim*). Florence, 1741.

[2] Alexandri ab Alexandro, Genialium Dierum, libri sex. There is a Paris edition of 1589, and a Leyden edition of 1673, in two volumes.

[3] History, Lib. II. cap. xiii.

having recognized the true nature of fossils, in despite of the popular notions that they were relics of the Scriptural deluge, or sports of nature generated within the solid rock through the operation of some occult force, or through the fermentation of a *materia pinguis.*

Throughout the sixteenth and seventeenth centuries the nature and origin of fossils remained a favorite topic of discussion. In the frequent and often vexed disputes of this period are to be observed on the one hand the influence of ecclesiastical prejudice, the Church claiming ability to explain all things, and possessing means of proved efficacy for compelling the acceptance of her views; and on the other hand the persistency of Aristotelian doctrines mingled with rank superstition. Such was the infertile soil into which the method of experiment and observation endeavored to send its roots. A tender plant in the beginning, its first green leaves withered, and during the long warfare between science and theology its growth was retarded. Concerning the methods in vogue during the period we are considering, it has been aptly remarked by Lyell[1] that "the system of scholastic disputations encouraged in the Universities of the middle ages had unfortunately trained men to habits of indefinite argumentation, and they often preferred absurd and extravagant propositions, because greater skill was required to maintain them; the end and object of these intellectual combats being victory and not truth. No theory could be so far-fetched or fantastical as not to attract some followers, provided it fell in with popular notions."

In the midst of such conditions as these it is pleasing to note the appearance of two men of remarkable insight, whose vision was in no wise clouded by the prevailing atmosphere of superstition and dogmatism. The first whom we have to consider is that versatile and brilliant genius, Leonardo da Vinci (1452–1519), of whom Humboldt remarked that "he was the first to start on the road towards the point where all the impressions of our senses convey the idea of the Unity of Nature." His clear exposition of the manner in which fossils have become preserved in the rocks offers a refreshing contrast to the prevailing views of the age, and although noticed by Humboldt,[2] Lyell and others, his remarks

[1] Lyell, C., Principles of Geology, I. chap. iii. London, 1834.

[2] Humboldt, A. von, Cosmos, II. chap. viii. Stuttgart, 1845. — Libri, G., Histoire des sciences mathématiques en Italie, III. Paris, 1840. — Lyell, C., Principles of Geology, I. chap. iii. London, 1830. — Raab, F., Leonardo da Vinci als Naturforscher, in Virchow and Holtzendorff's Sammlung gemeinverständl. Vorträge, ser. 15, p. 504. Berlin, 1880. — Ravaison-Mollien, C., Les manuscrits de Léonard de Vinci. Manuscrits *F* et *I* de la Bibliothèque de l'Institut. Paris, 1889. — Richter,

have not attracted the attention amongst geologists and palaeontologists which they deserve. An idea may be formed of the nature of his observations from the following extracts, translated literally from his published manuscripts: —

"All marine clays still contain shells, and the shells are petrified together with the clay. From their firmness and unity some persons will have it that these animals were carried up to places remote from the sea by the deluge. Another set of ignorant persons declare that Nature or Heaven created them in these places by celestial influences, as if in these places we did not also find the bones of fishes which have taken a long time to grow; and as if we could not count, in the shells of cockles and snails, the periods of their growth, as we do in the horns of bulls and oxen." — *Leic. MS.* 10 *a.*

"And if you were to say that these shells were created, and were continually being created in such places by the nature of the spot, and of the heavens which might have some influence there, such an opinion cannot exist in a brain of much reason; because here we find [lines denoting] annual growth numbered on their shells, and there are large and small shells to be seen which could not have grown without food, and could not have fed without motion, — and here they could not move." — *Leic. MS.* 9 *b.*

"As to those who say that shells existed for a long time and were formed at a distance from the sea from the nature of the place and of the cycles, which can influence a place to produce such creatures, — to them it must be answered: such an influence could not place the animals all on one level, except those of the same sort and age; and not the old with the young, nor some with an operculum and others without their operculum, nor some broken and others whole, nor some filled with sea-sand and large and small fragments of other shells inside the whole shell, which remained open; nor the claws of crabs without the rest of their bodies, nor the shells of other species adhering to them like animals which have moved about on them, since the impressions of their tracks still remain on the outside, after the manner of worms in the wood which they ate into. Nor would there be found among them the bones and teeth of fish which some call arrows and others serpents' tongues, nor would so many portions of various animals be found all together if they had not been thrown on the sea-shore." — *Leic. MS.* 9 *a.*

J. P., The Literary Works of Leonardo da Vinci, compiled and edited from the original manuscripts, II. chap. vi. London, 1883. — Uzzielli, G., Leonardo da Vinci e le Alpi. Turin, 1890. — Venturi, G. B., Essai sur les ouvrages physico-mathématiques de Léonard de Vinci. Paris, 1797. — Whewell, W., History of the Inductive Sciences, II. London, 1847. — White, A.D., History of the Warfare of Science with Theology, I. New York, 1896. The most sumptuously published of all Leonardo's writings is the *Codex Atlanticus* of the Ambrosian library in Milan, which has recently been reproduced in facsimile under the auspices of the Regia Accademia dei Lincei.

"*On Shells in the Mountains.* — And if you were to say that Nature has formed the shells in the mountains through the agency of the constellations, how will you explain it that the constellations create shells of divers species and of different ages in the selfsame spots? . . .

"*On Leaves.* — How will you explain the multitudinous leaves of different species solidified in the rocks high up in the mountains, and sea-weed commingled with shells and sand? And likewise you will see all [sorts of] petrifactions together with fragments of marine crabs, commingled with these shells." — *MS. F, folio* 80, *a*, *b* (*circa* 1510).

With the exception of the last fragment, which has been inaccurately paraphrased by Venturi, Lyell, and others, the above passages have not been noticed in geological literature. How far Leonardo's ideas are reflected by the commonly current paraphrase referred to may be seen on comparing it with the original text, a literal transcript of which follows: —

"*Denichi nemonti.*

"Essettu vorai dire linichi esserprodutti dalla natura inessi monti mediante leconstelatione per qual uia mosterai tal constellatione fare li nichi di uarie grandeze i eddi uerse eta edi uarie spetie nun medismo sito ——

"*Delle fogle.*

"Cone [Come] proverrai ilgrandissimo numero di uarie spetie di foglie congelata nellei *pietre* alti sassi di tal monti ellaligha erba dimare stande a diacere mista con nichi ecosiuderi onni cosa petrificato insieme congranche marini rotti inpezi etramezati tu essi nichi."

The second notable sixteenth-century personage whose opinions concern us is Girolamo Fracastoro, or in the more usual scholastic form, Hieronymus Fracastorius (1483–1553) of Verona, famous as physician, poet, and astronomer. A statue erected to his memory a few years after his decease attests the esteem in which he was held by his fellow-townsmen, and the eulogies pronounced upon him in foreign lands indicate a widespread recognition of his ability. Through the partiality of an enthusiastic fellow-countryman,[1] he has been allotted little short of an apotheosis, but the most trustworthy judgment is probably that of Libri, which is as follows: "Un seul nom, celui de Fracastoro, domine à présent les noms de tous ces astronomes italiens. Il fut célèbre par la profondeur et la variété de ses connaissances. De Thou, qui, dans son histoire, en a fait un magnifique éloge, dit que Sannazar s'avoua vaincu par les vers latins du médecin de Vérone. Il fut bota-

[1] Lioy, P., Linneo, Darwin, Agassiz nella vita intima. Milan, 1904.

niste, philosophe, et mathématicien, et, cultivant des sciences si diverses, il s'illustra dans toutes."[1]

Fracastoro resembled his illustrious contemporary Leonardo in his ability to deduce sound conclusions from observed facts, and in his habit of appealing directly to nature rather than to authority for answer to the problems confronting him. His opinions in regard to the nature of fossils, a variety of which were brought to his attention during the reconstruction of a citadel in Verona in 1517, are set forth very clearly in a description of the Calceolarian Museum,[2] a work frequently referred to by the older writers, and also in an historical account of Verona by Torello Saraina.[3] Fracastoro ridicules the notion that fossils are the reliquiae of the Mosaic deluge, or were formed within the rocks through the agency of a plastic force, and states his reasons for believing them to be the remains of plants and animals which inhabited the sea at a period when the continents were submerged. Had these sensible views been heeded, much useless discussion which continued throughout the succeeding two centuries would have been avoided.

A brief notice concerning the fossil fishes of Monte Bolca, the earliest in which they are specifically referred to, was inserted by the celebrated botanist Mattioli[4] in his fourth edition of the *Materia Medica* of Dioscorides, which he commentated and illustrated in 1552. He also quotes the statements of Polybius, in Book XXXIV. of his History, re-

[1] *Op. cit.*, II. p. 101.

[2] Chiocco, A., and Ceruti, B., Musaeum Franc. Calceolari iun. Veronensis. Verona, 1622. The passage entitled "Magni Fracastorii Sententia de proposita quaestione," which occurs on p. 407 of this work, is quoted *in extenso* by Vallisneri in his *De' corpi marini che su' monti si trovano* (Venice, 1721), and is referred to by various other authors prior to Lioy. A figure evidently of *Holocentrum macrocechalum* is given on p. 428 of this work.

[3] Saraina, T., De Origine et Amplitudine Civitatis Veronae. Verona, 1530.

See also on Fracastoro the following: Barbarini, E., Girolamo Fracastoro e le sue opere. Verona, 1894. — Caverni, R., Storia del metodo sperimentale in Italia. Florence, 1893.— Holden, E. S., The Precursors of Copernicus (Pop. Sci. Monthly, LXIV. p. 316), 1904. — Lioy, P., Fracastoro e le sue idee divinatrici della Paleontologia (Atti R. Istit. Veneto, ser. 7, IX. p. 1098), 1898. — Meneghini, G., Dei meriti dei Veniti nelle Geologia. Pisa, 1866. — Menken, O., De vita, moribus, scriptis meritisque H. Fracastori Veronensis. Leipzic, 1731. — Omboni, G., Cenni sulla storia della Geologia. Padua, 1894. — Stoppani, A., Della preminenza e priorità degli studj geologici in Italia. Milan, 1868.

[4] Mattioli, P. A., Commentarii secondo aucti, in libros sex Pedaci Dioscoridis de Medica Materia, 4th ed., Venice, 1552; 5th, *ibid.*, 1558. The reference occurs in the Introduction to Book V., and is wanting in earlier editions of this work.

garding the "subterranean fish" of Narbonne and the views of earlier writers on the nature of fossils in general.

About this time interest became awakened in the formation of natural history collections, first in Italy, where zoölogical gardens had long since been introduced, and afterwards generally throughout Europe. One of the earliest and at the same time most extensive, was the museum founded at Verona in 1572 by Francesco Calceolari, which contained a number of Bolca fishes, and was the fruitful source of several publications. Ulisse Aldrovandi (1522–1607), a noted scientist and professor at the University of Bologna, brought together a large private collection, out of which grew eventually the Public Museum of Bologna, and descriptions of his minerals and fossils were published some years after his death.[1] In 1574 an elaborate description was prepared by Mercato, but not published until nearly a century and a half later, of the Vatican collection of minerals, fossils, and antiquities which had been brought together under the auspices of Pope Sixtus V. The priestly author, however, was content to believe that not only fossils, but even ancient pottery and inscriptions were mineral concretions which had assumed their shapes through the influence of celestial bodies.[2] Agassiz contemptuously remarks of this work that it is a "compilation sans valeur et sans goût." The physician Olivi of Cremona, who described in 1584 the fossils contained in the Calceolarian Museum,[3] was likewise prejudiced in regarding them as *lusi naturae*. Nevertheless his work was deemed worthy of being reprinted nine years later, and new illustrations of the same museum appeared in 1622, at the hands of Ceruti and Chiocco, as already noted. It is in this work that the opinions of Fracastoro, announced more than a century earlier, are at last accorded recognition. Among the curiosities of palaeontological literature belonging to this period should be mentioned Buonamici's dissertation on *Glossopetrae*,[4] published in 1668.

Seventeenth and Eighteenth Centuries. The important contributions to palaeontology made by Fabius Colonna, Nicolas Steno, and Augustin Scilla during the seventeenth century are well known, hence we

[1] Ambrosini, Musaeum metallicum. 1648.

[2] Mercato, M., Metallotheca [Vaticana], opus posthumum. Rome, 1717.

[3] Olivi, G. B., De reconditis et praecipuis collectaneis a Francesco Calceolario Veronensis, in Museo adservatis. Verona, 1584; and Venice, 1593.

[4] Buonamici, F., Sulle glossopetre, gli occhi di serpe ed altre pietre, etc. (Opusc. Sicil. Vol. XII.), 1668. References to other essays of this period on the same subject will be found in Palaeontographica, XLI. pp. 149–153, 1895.

may pass over these authors with the bare mention of their names.[1] Throughout this period the growth of museums continued apace, and attempts to describe their fossil contents succeeded better as Fracastoro's ideas were revived and gradually gained acceptance. Descriptions appeared of the Aldrovandi collection in 1648, as has been stated, and in 1656 of Count Moscardo's[2] museum in Verona, both of which contained interesting fish remains. Another museum famous for its fossils was that of Zannichelli[3] of Venice, who prepared an elaborate catalogue of its contents, published first in 1720, with additions in 1736. Attention should also be called to the important essay by Vallisneri[4] "*On Marine Bodies found in the Mountains*," published in 1721, in which reference is made to the fishes and crustaceans occurring at Monte Bolca. Appended to the complete works of this author is a letter on Bolca fishes, with a map of the locality, by Ferdinand Marsili.[5]

As remarked by Lyell, the writings of Vallisneri are rich in geological observations. He attempted the first general sketch of the marine deposits of Italy, their geographical extent and most characteristic organic remains, and was the principal opponent amongst his countrymen of Woodward's diluvian hypothesis. In 1702 the fossil fishes of Monte Bolca were made the subject of a communication before the French Academy by Maraldi,[6] an Italian astronomer, and the same body was similarly addressed by J. J. Scheuchzer, whose "*Piscium querelae et vindiciae*" and other writings provoked wide-spread discussion. Notices of vertebrate remains appear also in the dissertations of Spada,[7]

[1] On these writers one may consult the following: Seguenza, G., Agostino Scilla. Messina, 1868. — Marsh, O. C., History and Methods of Palaeontological Discovery (Proc. Amer. Assoc. Adv. Sci. 1879), 1880. — Ward, L. F., Sketch of Palaeobotany, Fifth Ann. Rept. U. S. Geol. Surv. (1883-1884), 1885. — Zittel, K. A., Geschichte der Geologie und Paläontologie. Munich, 1899.

[2] Note overo memorie del Museo di Lodovico Moscardo, dal medesimo descritte. Padua, 1656. Some poor figures of Bolca fishes are given on p. 182.

[3] Zannichelli, Apparatus rariorum Musaei Zannicchelli. Venice, 1720. *Idem*, Enumeratio rerum naturalium Musaei Zannichelli. Venice, 1736. This catalogue contains the earliest mention of fossil hippopotami in Italy.

[4] Vallisneri, A., De' corpi marini che su' monti si trovano. Venice, 1721.

[5] Vallisneri, A., Opere, II. p. 359.

[6] Maraldi, J. P., Diverses observations de physique génerale, § xi. (Hist. Acad. Roy. Sci., année 1703). Paris, 1720. This is the earliest communication on Bolca fishes published by any learned society. The earliest in English is a paper by G. Graydon, entitled "On the fish enclosed in stone of Monte Bolca," which appears in the transactions of the Royal Irish Academy for 1794 (Vol. V., p. 281).

[7] Spada, J. J., Dissertazione ove si prova che i corpi marini petrificati non sono

a learned priest of Grezzana, who wrote in 1737, and again in 1744, to prove that the fossils found near Verona were not of diluvian origin. Scipio Maffei [1] was another active collector and writer on Bolca fishes during the middle of the eighteenth century. But we cannot dwell upon any of the numerous minor publications of this time, nor even upon the more important contributions of Moro,[2] Generelli,[3] and others. With this brief sketch we must conclude our survey of pre-Linnaean literature, and pass on to the modern era; for from the time of the two great Swedish naturalists onward, Linné and Artedi, the latter of whom is justly styled the "father of ichthyology," a new order of things existed.

One of the earliest writers of the new era in natural science, and indeed the first who attempted a specific determination of the Bolca fishes, was Cammillo Zampieri d'Imola,[4] whose Catalogue of the Ginanni Museum, published in 1762, is decidedly meritorious. His identification of species, however, based as it was upon the treatises of Willoughby and Ray, was altogether faulty. The celebrated Fortis also made unsuccessful endeavors to identify Bolca fishes with the species described by Bloch and Broussonet. Fortis had already noted the occurrence of fossil fishes [5] in other parts of the Alpine strata, but on turning his attention to the Bolca forms, he encountered difficulties.[6] He was mis-

diluviani. Verona, 1737. — *Idem*, Corporum lapidefactorum agri veronensis catalogus. Verona, 1744. In Plate ii. of this work is given a tolerable figure of *Semiophorus*. See also Cobres's estimate of Spada, in Büchersammlung der Naturgeschichte, I. p. 20.

[1] Maffei, F. S., Del Monte Bolca, della sua Pesciaia, e degli annessi Monti Calonnari, etc., in his *Compendio della Verona Illustrata*, Vol. I., pp. 217–230, pl. i.–viii. Verona, 1795.

[2] Moro, L., Sui crostacei ed altri corpi marini che si trovano sui monti. 1740. The same work was also published in German under the title of "Neue Untersuchungen über die Abänderungen der Erde." Leipzic, 1751.

Moro's ideas were appropriated without acknowledgment by Edward King in a paper read before the Royal Society entitled "An attempt to account for the Universal Deluge" (Phil. Trans., LVII. pp. 44–57), 1767. For a biographical sketch of Lazzaro Moro see Giornale di Storia naturale del Griselini, I. p. 79.

[3] Generelli, C., Dei crostacei e di altre produzione del mare. 1749.

[4] Zampieri, C., Produzione naturali che si ritrovano nel Museo Ginanni in Ravenna. Lucca, 1762.

[5] Fortis, A., Viaggi in Dalmazia, II. p. 239. 1774.

[6] Fortis, A., Extrait d'une lettre, etc. Journ. de Phys., XXVIII. 1786. In a later communication to the same journal, Fortis vigorously disclaims authorship of the catalogue of Bolca fishes which is appended to his first article. In this anonymous postscript an extravagant valuation (28,000 liv.) is placed upon the Bozza Collection, which then consisted of about six hundred specimens.

led into supposing certain species to be identical with modern tropical forms, and his somewhat fanciful theories to explain their occurrence in northern Italy plunged him into a spirited controversy with another prominent naturalist, Domenica Testa. Their letters, written in a style that is both elegant and incisive, show wide erudition and good argumentative ability on both sides. The correspondence was finally collected and published in book form, with comments of his own, by Count Giambattista Gazola [1] of Verona, in 1793 and 1794.

By this time a very lively interest had arisen in regard to the fishes of Monte Bolca, and the Veronese collections became greatly augmented as the result of excavations that had been undertaken on purpose to secure them. The culmination of this activity was marked by the appearance in 1796 of an elaborate work by G. Serafino Volta, entitled *Ittiolitologia Veronese.* In the compilation of this famous monograph, which was illustrated by nearly fourscore excellent plates, Volta was aided by several collaborators, chief amongst whom was Count Gazola himself. Volta had already published in 1789 a list of the fossil fishes occurring at Monte Bolca,[2] in which about one hundred species were enumerated, and of these twenty-five were erroneously identified with recent forms. The determinations in his final memoir were scarcely more fortunate, Agassiz having afterwards declared that there was only one [3] adequately established species in the whole work, that one being *Blochius longirostris.* The practical value of Volta's work, however, was immeasurably increased by the redetermination of his originals, an authentic list of the figured specimens being published by Agassiz [4] in 1833. In this list Volta's originals are regarded as belonging to 90 species and 69 genera, all of the species being marine, and none of them represented in the existing fauna.

[1] Gazola, G., Lettere recentemente pubblicate sui pesci fossili veronesi, con annotazioni inediti agli estratti delle medesime. Milan, 1793, and Verona, 1794.

[2] Volta, G. S., Degl' impietrimenti del Territorio Veronese, etc. Lettera al Sig. Vincenzo Bozza, 1789. *Idem,* Prospetto del Museo Bellisomi. 1787.

[3] This is not strictly true. The names of over a dozen species described by Volta as new are rejected by Agassiz, and others substituted, for the reason that the forms were regarded in the first instance as belonging to existing genera. A list of the species which should properly be credited to Volta is as follows:

Blochius longirostris, Eocottus veronensis, Ephippus asper, Ductor vestenae, Mene rhombeus, Monopterus gigas, Platax papilio, Pygaeus bolcanus, Pycnodus apodus, Rhamphosus rastrum, Rhinellus lesiniformis, Semiophorus velifer, Vomeropsis triurus, Xiphopterus falcatus.

[4] Agassiz, L., Revue critique des Poissons Fossiles figurés dans l'Ittiolitologia Veronese. Neuchâtel, 1833. Also in German in the Neues Jahrbuch for 1835.

Volta narrates in considerable detail the history of the principal collections which furnished him with material. Of these there were ten belonging to Veronese gentlemen, the most notable one being the property of Count Gazola, with which the Bozza and Dionisi collections became shortly afterwards united. The circumstances which deprived Count Gazola of most of his specimens in 1797, their removal to Paris by order of First Consul Bonaparte, and their presentation by him to the Museum of Natural History in that city are familiar historical facts.

The second largest suite of fossil fishes was that belonging to the Marchese Ottavio di Canossa, which afterwards became enlarged by the purchase of Julius Cæsar Moreni's collection. Agassiz never had access to the Canossa Collection, nor in fact to any in Italy, but portions of it were described by subsequent authors at various times. The collection remained intact at Verona until 1903, when it passed into the possession of natural history dealers and museums of several countries. Heckel's figured specimen of *Palaeobalistum orbiculatum*, for instance, was acquired by the British Museum, Massalongo's types of *Archiophis* were divided between the Harvard and Berlin Museums, and the Carnegie Museum at Pittsburg also obtained several of Massalongo's figured specimens.

Count Gazola's first care on suffering the loss of his splendid collection was to undertake the formation of a new one. Excavations at Bolca were recommenced, and on the death of Count Ronconi a number of fine specimens which he had brought together passed into Gazola's hands; the result of all this activity being that, phoenix-like, his museum became speedily rehabilitated. This second collection of Count Gazola is preserved in the Museo Civico of Verona, but is not now, and unfortunately never has been, fully accessible for study. The scientific value of this collection was fully appreciated by Jacob Heckel, who first visited it in 1850. The condition in which he found the museums of Verona, Padua, Venice, and other cities at that time is set forth by him in a highly entertaining narrative which he communicated to the Vienna Academy,[1] under whose patronage the journey was undertaken. In referring to the Gazola Collection, he laments particularly the fact that it never came under Agassiz's observation, for this "heerliches Material," as he calls it, would have helped him to a much more complete understanding of many interesting species, and even genera, and would have enriched our knowledge of the Bolca fauna with valuable details.

[1] Heckel, J., Bericht über eine Reise, etc. (Sitzungsber Akad. Wissensch. Wien, VII. p. 318), 1851.

Heckel also remarks that the same collection "ist bei weitem reicher als jene des Marchese Canossa und liefert eine beinahe vollständige Uebersicht sämmtlicher organischer Reste, welche in den tertiären Ablagerungen des Monte Bolca enthalten sind."

The only other private collection which we need notice here is that brought together early in the nineteenth century by Luigi Castellini, of Castelgomberto, which now forms one of the principal treasures of the Padua Museum. This comprised in all about five hundred fishes from Monte Bolca and Monte Postale, some of which were remarkable for their large size and excellent preservation, as well as for their rarity. "Sie ist auf drei grossen Doppelpulten aufgestellt," writes Heckel in his naïve narrative of 1850, "und enthält ausser vielen der seltenen Arten und manchen Prachtstücke, sämmtliche in Doppelplatten, auch einige bisher unbeschriebene Species, deren nähere Bekanntschaft mich um so angenehmer berührte, da ich bereits mehrere derselben zu Verona in der schönen Sammlung des Herrn Grafen Gazola unter Glas bemerkt hatte." Some of these new forms were shortly afterwards described by Heckel, and others have been investigated by more recent writers.

We return now to the first Gazola Collection, which, as we have seen, was transported to Paris in 1797, and deposited in the Museum of Natural History. It is well known that Cuvier spent considerable time in the investigation of this material, with the intention of preparing a monograph upon it, — a task, however, which was ceded finally to Agassiz. Some use of the collection was made by de Blainville in the preparation of his article[1] on fossil fishes, published in 1818, but it cannot be said that our knowledge was materially increased by this author. It remained for the elder Agassiz, in 1831 and 1832, to ascertain the true nature of the extinct forms of fish life here represented, and by means of this and other collections which he studied, to give the first accurate and best general account we possess of the remarkable ichthyic fauna occurring at Monte Bolca.

Agassiz's own estimate of the value of the Gazola Collection is thus expressed by him: "Le Muséum d'Histoire Naturelle de Paris a été pour moi l'une des mines les plus riches que j'aie exploitée. . . . La collection de poissons fossiles la plus importante qui existe maintenant, et en même temps qui offre le plus d'intérêt historique, est, sans contredit, celle du comte de Gazola, qui a fourni les originaux pour l'*Ittiolitologia Veronese*. . . . Je l'ai entièrement revue et complète-

[1] De Blainville, H. D., Sur les Ichthyolites, ou les Poissons Fossiles, in his Nouveau Dictionnaire d'Histoire Naturelle, Vol. XXVIII. Paris, 1818.

ment décrite vers la fin de 1831 et pendant les huit premiers mois de l'année 1832, et j'ai inscrit mes déterminations sur le revers de toutes les plaques." [1]

The total number of species recognized by Agassiz as the result of his investigations of the Gazola Collection and other Bolca material that came under his observation was 127, and the total number of genera 77. Many of Volta's types were refigured by him, but in several cases descriptions were given without fresh illustration, and in others Volta's figures were merely renamed without further description. Some confusion in the nomenclature was occasioned by reason of other names being applied to species which had been duly established both by Volta and by de Blainville, and in about a dozen instances MS. names were proposed for certain forms which up to the present time have remained undescribed. These *types inédits,* designated as such in Agassiz's handwriting, have recently been investigated by the present writer, and their publication undertaken by the French Geological Society. It must not be supposed, however, that all of Volta's types which originally formed part of the Gazola Collection are now preserved in the Paris Museum, nor was it possible even in Agassiz's time to account for the specimens which were then missing.[2] Owing to the historic and scientific interest attaching to these originals, it is to be hoped that all such as are still in existence and have escaped notice amongst other collections may again come to light. Lists are given below of all the types and hypotypes belonging to the Gazola Collection in Paris.

It will be sufficient to pass over the post-Agassizian literature of the Bolca fish-fauna very briefly, merely indicating the names of the principal contributors. These are, in chronological order, Jacob Heckel, Rudolf Kner, Franz Steindachner, Raffaele Molin, Abramo Massalongo, Paolo Lioy, Achille de Zigno, Francesco Bassani, Wladislaw Szajnocha,

[1] Agassiz, L., Poissons Fossiles, I. p. 5. Neuchâtel, 1833.

[2] The Library of the Museum of Comparative Zoölogy possesses the identical copy of Volta's work employed by Professor Agassiz in his determinations of the types in the Gazola Collection at Paris. Each figure of the plates is marked with Agassiz's revised designation, and in cases where the originals were wanting, the fact is so indicated. His private copy of de Blainville's *Poissons Fossiles,* in the same library, likewise contains valuable corrections and annotations. The Museum has received through Prof. R. T. Jackson, who obtained it from Prof. J. E. Wolff, a specimen which formerly belonged to the Gazola Collection at Paris, but which disappeared from it probably during some of the early vicissitudes through which the collection passed. Several interesting notices of the latter are to be found in the papers of Faujas-St.-Fond, de Jussieu, Cuvier, and others, published in the early volumes of the *Annales* and of the *Mémoires du Museum d'Histoire Naturelle.*

Carl Gorganovic-Kramberger, Otto Jaekel, and A. Smith Woodward. Some seventy-five additional species have been described by these authors in the aggregate, making a total representation of slightly more than two hundred. A rather considerable number of these, however, are undoubtedly synonyms, and the status of a score or more of imperfectly defined species requires further investigation.

The best general account of the geology of the region in which this fish-fauna occurs is contained in an inaugural dissertation by the late Munier-Chalmas, entitled "*Étude du Tithonique, du Crétacé et du Tertiaire du Vicentin*" (Paris, 1891), the usefulness of which is increased by a copious bibliography. Mention should also be made of Enrico Nicolis' "*Carta Geologica della Provincia di Verona*" (Verona, 1882), and of his "*Sugli antici Corsi dell' Adige*" (Rome, 1898). The invertebrate fauna of Monte Bolca forms the subject of special memoirs by Cattullo [1] and Oppenheim.[2]

LIST OF SPECIMENS IN THE GAZOLA COLLECTION OF THE PARIS MUSEUM FIGURED IN VOLTA'S "ITTIOLITOLOGIA VERONESE," ARRANGED IN SERIAL ORDER.

VOLTA (*Itt. Ver.*).		REFIGURED BY AGASSIZ (*Poissons Fossiles*).
Pl. 3, Fig. 1.	*Carcharias* (*Scoliodon*) *cuvieri* (Ag.).	
4.	*Platax pinnatiformis* (Blv.).	Vol. IV. Pl. 41.
5, " 1.	*Aulostoma bolcense* (Blv.).	Vol. IV. Pl. 35, Fig. 3.
5, " 2.	*Fistularia longirostris* (Blv.).	Vol. IV. Pl. 35, Fig. 4.
5, " 3.	*Calamostoma breviculum* (Blv.).	Vol. II. Pl. 74, Fig. 1.
5, " 4.	*Rhamphosus rastrum* (Volta).	Vol. IV. Pl. 32, Fig. 7.
7, " 1.	*Semiophorus velifer* (Volta).	Vol. IV. Pl. 37 *a*, Fig. 2.
7, " 2.	" " "	Vol. IV. Pl. 37 *a*, Fig. 1.
7, " 3.	" *velicans* (Blv.).	Vol. IV. Pl. 37.
8, " 1.	*Pomacanthus subarcuatus* (Blv.).	Vol. IV. Pl. 19, Fig. 2.
9, Figs. 1, 2.	*Trygon muricatus* (Volta).	
10, Fig. 1.	*Ephippus rhombus* (Blv.).	
11, " 1.	*Eocottus veronensis* (Volta).	Vol. IV. Pl. 34, Fig. 3.
11, " 2.	" " "	Vol. IV. Pl. 34, Fig. 4.
12, " 1.	*Blochius longirostris* Volta.	Vol. II. Pl. 44, Fig. 3.
12. " 2.	" " "	

[1] Cattullo, T. A., Memorie sopra li corpi organizzati fossili del Bolca, etc. (Giornale di Pavia), 1818–22.

[2] Oppenheim, P., Die Eocänfauna des Monte Postale bei Bolca in Veronesischen (Palaeontographica, XLIII. pp. 125–222), 1896.

Volta (*Itt. Ver.*).		Refigured by Agassiz (*Poissons Fossiles*).
Pl. 13, Fig. 1.	*Sparnodus vulgaris* (Blv.).	Vol. IV. Pl. 29, Fig. 2.
13, " 2.	*Spinacanthus cuneiformis* (Blv.).	Vol. V. Pl. 39, Fig. 1.
14, " 1.	*Enoplosus pygopterus* Ag.	Vol. IV. Pl. 9, Fig. 1.
17, " 1.	*Sparnodus vulgaris* (Blv.).	Vol. IV. Pl. 29, Fig. 2.
17, " 3.	*Lates gracilis* Ag.	Vol. IV. Pl. 3, Fig. 2.
19.	*Acanthonemus subaureus* (Blv.).	Vol. V. Pl. 4.
20, " 1.	*Ephippus asper* (Volta).	
20, " 2.	*Pristigenys substriatus* (Blv.).	
22, " 1.	*Naseus nuchalis* Ag.	Vol. IV. Pl. 36, Fig. 2.
23, " 1.	*Ophisurus acuticaudus* Ag.	
23, " 3.	*Anguilla leptoptera* Ag.	
24, " 3.	*Rhamphognathus sphyraenoides* (Ag.).	Vol. V. Pl. 38, Fig. 2.
25, " 1.	*Chanoides macropoma* (Ag.).	
25, " 2.	" " "	Vol. V. Pl. 37 *b*, Fig. 4.
26, " 1.	*Platax papilio* (Volta).	Vol. IV. Pl. 42.
26, " 2.	*Zanclus brevirostris* Ag.	Vol. IV. Pl. 38, Figs. 1, 2.
27.	*Thynnus* (?) *bolcensis* Ag.	
29, " 1.	" *lanceolatus* (Ag.).	
29, " 4.	*Urosphen dubia* (Blv.).	
30.	*Callipteryx recticaudus* Ag.	Vol. IV. Pl. 33, Fig. 2.
31, " 1.	*Sparnodus elongatus* Ag.	Vol. IV. Pl. 28, Fig. 1.
31, " 2.	*Acanthurus tenuis* Ag.	Vol. IV. Pl. 36, Fig. 1.
32, " 1.	*Sparnodus elongatus* Ag.	Vol. IV. Pl. 23 *b*, *infra*.
32, " 2.	*Ductor vestenae* (Volta).	Vol. V. Pl. 12.
33.	*Naseus rectifrons* Ag.	Vol. IV. Pl. 36, Fig. 3.
35, " 1.	*Pycnodus apodus* (Volta).	
35, " 3.	*Vomeropsis triurus* (Volta).	Vol. V. Pl. 5.
35, " 4.	*Cyclopoma* (?) *micracanthum* (Ag.).	
37.	*Labrus valenciennesi* Ag.	Vol. V. Pl. 39, Fig. 2.
38, " 1.	*Paranguilla tigrina* (Ag.).	Vol. V. Pl. 49.
39, " 3.	*Trachynotus tenuiceps* Ag.	Vol. V. Pl. 7, Figs. 1, 2.
39, " 5.	*Engraulis evolans* (Ag.).	Vol. V. Pl. 37 *b*, Figs. 1, 2.
40.	*Palaeobalistum orbiculatum* (Blv.).	
42, " 1.	*Ostracion dubius* (Blv.).	Vol. II. Pl. 74, Figs. 4, 5.
42, " 2.	"*Pegasus volans*" Linn. (indeterminable).	
42, " 3.	*Lophius brachysomus* Ag.	Vol. V. Pl. 40, Figs. 1, 2.
44, " 1.	*Amphistium paradoxum* Ag.	
44, " 2.	*Vomeropsis triurus* (Volta).	Vol. V. Pl. 6.
45, " 1.	*Toxotes antiquus* Ag.	Vol. IV. Pl. 43.
45, " 2.	*Dules temnopterus* Ag.	Vol. IV. Pl. 21, Figs. 1, 2.
45, " 3.	*Sparnodus microstomus* (Ag.).	
47.	*Monopterus gigas* Volta.	
48, " 3.	*Atherina macrocephala* Ag.	

Volta (*Itt. Ver.*).		Refigured by Agassiz (*Poissons Fossiles*).
Pl. 51, Fig. 2.	*Holocentrum macrocephalum* Blv.	Vol. IV. Pl. 14.
51, " 3.	*Acanthonemus subaureus* (Blv.).	Vol. V. Pl. 3.
53, " 2.	*Leptocephalus medius* Ag.	
54.	*Dentex leptacanthus* Ag.	Vol. IV. Pl. 26.
55, " 1.	*Blochius longirostris* Volta. (The head of an anguilliform fish has been substituted for the one properly belonging to this specimen.)	
55, " 2.	*Orycynus latior* Ag.	Vol. V. Pl. 24.
56, " 2.	*Apogon spinosus* Ag.	Vol. IV. Pl. 9, Figs. 2, 3.
56, " 3.	*Cyclopoma* (?) *micracanthum* (Ag.).	
57.	*Xiphopterus falcatus* (Volta).	
58, " 1.	*Pseudosyngnathus opisthopterus* (Ag.).	
58, " 2.	*Ductor vestenae* (Volta).	
59.	*Pygaeus bolcanus* (Volta).	Vol. IV. Pl. 20.
60, " 2.	*Sparnodus vulgaris* (Blv.).	Vol. IV. Pl. 28, Fig. 3.
61.	*Platyrhina gigantea* (Blv.).	
62.	*Sphyraena bolcense* Ag.	
69, " 1.	*Seriola analis* Ag.	
70.	*Blochius longirostris* Volta.	
72, " 1.	*Holocentrum macrocephalum* Blv.	
72, " 4.	*Myripristis homopterygius* Ag.	
73.	*Sparnodus vulgaris* (Blv.).	
74.	*Cyclopoma gigas* Ag.	
75 " 1.	*Rhamphosus rastrum* (Volta).	
76.	*Cyclopoma spinosum* Ag.	

Alphabetical List of the Type and Figured Specimens of Bolca Fishes Belonging to the Gazola Collection, now preserved in the Paris Museum of Natural History.

1.	*Acanthonemus subaureus* (Blv.).	Volta, Pl. 51, Fig. 3; Ag., V. Pl. 3.
2.	" " "	Volta, Pl. 19; Ag., V. Pl. 4.
3.	*Acanthurus tenuis* Ag.	Volta, Pl. 31, Fig. 2; Ag., IV. Pl. 36, Fig. 1.
4.	*Amphistium paradoxum* Ag.	Volta, Pl. 44, Fig. 1.
5.	" "	Ag., V. Pl. 13.
6.	*Anguilla branchiostegalis* Ag. (MS.).	
7.	" *brevicula* Ag.	Ag., V. Pl. 43, Fig. 1.
8.	" *leptoptera* Ag.	Volta, Pl. 23, Fig. 3.
9.	*Apogon spinosus* Ag.	Volta, Pl. 56, Fig. 2; Ag., IV. Pl. 9, Figs, 2, 3.
10.	*Atherina macrocephala* Ag.	Volta, Pl. 48, Fig. 3.

11.	*Aulostoma bolcense* (Blv.).	Volta, Pl. 5, Fig. 1; Ag., IV. Pl. 35, Fig. 3.
12.	" " "	Ag., IV. Pl. 35, Fig. 2.
13.	*Blochius longirostris* Volta.	Volta, Pl. 12, Fig. 1; Ag., II. Pl. 44, Fig. 3.
14.	" " "	Volta, Pl. 12, Fig. 2.
15.	" " "	Volta, Pl. 55, Fig. 1.
16.	" " "	Volta, Pl. 70.
17.	*Calamostoma breviculum* (Blv.).	Volta, Pl. 5, Fig. 3; Ag., II. Pl. 74, Fig. 1.
18.	*Callipteryx recticaudus* Ag.	Volta, Pl. 30; Ag., IV. Pl. 33, Fig. 2.
19.	" *speciosus* Ag.	Ag., IV. Pl. 33, Fig. 1.
20.	*Carangopsis dorsalis* Ag.	Ag., V. Pl. 8.
21.	*Carcharias (Scoliodon) cuvieri* (Ag.).	Volta, Pl. 3, Fig. 1.
22.	*Chanoides leptostea* Ag. (MS.).	
23.	" *macropoma* (Ag.).	Volta, Pl. 25, Fig. 1.
24.	" " "	Volta, Pl. 25, Fig. 2; Ag., V. Pl. 37 *b*, Fig. 4.
25.	*Coelogaster analis* Ag. (MS.).	
26.	*Cybium speciosum* Ag.	Ag., V. Pl. 25.
27.	*Cyclopoma gigas* Ag.	Ag., IV. Pl. 2.
28.	" " "	Volta, Pl. 74.
29.	" (?) *micracanthum* (Ag.).	Volta, Pl. 35, Fig. 4.
30.	" *spinosum* Ag.	Volta, Pl. 76.
31.	" " "	Ag., IV. Pl. 1.
32.	*Dentex crassispinus* Ag.	
33.	" *leptacanthus* Ag.	Volta, Pl. 54; Ag., IV. Pl. 26.
34.	*Ductor vestenae* (Volta).	Volta, Pl. 32, Fig. 2; Ag., V. Pl. 12.
35.	" " "	Volta, Pl. 58, Fig. 2.
36.	*Dules temnopterus* Ag.	Volta, Pl. 45, Fig. 2; Ag., IV. Pl. 21, Figs. 1, 2.
37.	*Engraulis evolans* Ag.	Volta, Pl. 39, Fig. 5; Ag., V. Pl. 37 *b*, Figs. 1, 2.
38.	*Enoplosus pygopterus* Ag.	Volta, Pl. 14, Fig. 1; Ag., IV. Pl. 9, Fig. 1.
39.	*Eomyrus formosissimus* (Ag.) (MS.).	
40.	" *interspinalis* " "	
41.	" *latispinus* (Ag.).	Ag., V. Pl. 43, Fig. 4.
42.	*Eocottus veronensis* (Volta).	Volta, Pl. 11, Fig. 1; Ag., IV. Pl. 34, Fig. 3.
43.	" " "	Volta, Pl. 11, Fig. 2; Ag., IV. Pl. 34, Fig. 4.
44.	*Ephippus asper* (Volta).	Volta, Pl. 20, Fig. 1.
45.	" " "	Ag., IV. Pl. 39, Fig. 3.
46.	" *rhombus* (Blv.).	Volta, Pl. 10, Fig. 1.

47. *Ephippus rhombus* (Blv.).	Ag., IV. Pl. 40.
48. *Fistularia longirostris* (Blv.).	Volta, Pl. 5, Fig. 2; Ag., IV. Pl. 35, Fig. 4.
49. *Holocentrum macrocephalum* Blv.	Volta, Pl. 51, Fig. 2; Ag., IV. Pl. 14.
50. " " "	Volta, Pl. 72, Fig. 1.
51. " *pygmaeum* Ag.	Ag., IV. Pl. 15, Fig. 1.
52. *Holosteus esocinus* Ag.	Ag., V. Pl. 43, Fig. 5.
53. *Labrax schizurus* Ag.	Ag., IV. Pl. 13, Fig. 3.
54. *Labrus valenciennesi* Ag.	Volta, Pl. 37; Ag., V. Pl. 39, Fig. 2.
55. *Lates gracilis* Ag.	Volta, Pl. 17, Fig. 3; Ag., IV. Pl. 3, Fig. 2.
56. " " "	Ag., IV. Pl. 5.
57. *Leptocephalus medius* Ag.	Volta, Pl. 53, Fig. 2.
58. *Lophius brachysomus* Ag.	Volta, Pl. 42, Fig. 3; Ag., V. Pl. 40, Figs. 1, 2.
59. " " "	Ag., V. Pl. 40, Figs. 3, 4.
60. *Mene oblongus* (Ag.).	Ag., V. Pl. 1, Figs. 1, 2.
61. *Monopterus gigas* Volta.	Volta, Pl. 47.
62. *Myripristis homopterygius* Ag.	Volta, Pl. 72, Fig. 4.
63. *Naseus nuchalis* Ag.	Volta, Pl. 22, Fig. 1; Ag., IV. Pl. 36, Fig. 2.
64. " *rectifrons* Ag.	Volta, Pl. 33; Ag., IV. Pl. 36, Fig. 3.
65. *Odonteus sparoides* Ag.	Ag., IV. Pl. 39, Fig. 2.
66. *Ophisurus acuticaudus* Ag.	Ag., V. Pl. 23, Fig. 1.
67. *Orycynus latior* Ag.	Volta, Pl. 55, Fig. 2; Ag., V. Pl. 24.
68. *Ostracion dubius* (Blv.).	Volta, Pl. 42, Fig. 1; Ag., II. Pl. 74, Figs. 4, 5.
69. *Pagellus microdon* Ag.	Ag., IV. Pl. 27, Fig. 1.
70. *Palaeobalistum orbiculatum* (Blv.).	Volta, Pl. 40.
71. *Paranguilla tigrina* (Ag.).[1]	Volta, Pl. 38, Fig. 1; Ag., V. Pl. 49.
72. "*Pegasus volans*" Linn.	Volta, Pl. 42, Fig. 2.
73. *Pelates quindecimalis* Ag.	Ag., IV. Pl. 22.
74. *Platax papilio* (Volta).	Volta, Pl. 26, Fig. 1; Ag., IV. Pl. 42.
75. " *pinnatiformis* (Blv.).	Volta, Pl. 4; Ag., IV. Pl. 41.
76. " *subvespertilio* (Blv.).	Volta, Pl. 6.
77. " " "	Ag., IV. Pl. 41 *a*.
78. *Platinx intermedius* Eastm.	*(In press.)*
79. " *macropterus* (Blv.).	Ag., V. Pl. 14.
80. *Platyrhina gigantea* (Blv.).	Volta, Pl. 61.
81. *Pomacanthus subarcuatus* (Blv.).	Volta, Pl. 8, Fig. 1; Ag., IV. Pl. 19, Fig. 2.
82. *Pristigenys substriatus* (Blv.).	Volta, Pl. 20, Fig. 2.
83. *Pristipoma furcatum* (Ag.).	Ag., IV. Pl. 39, Fig. 1.
84. *Pseudosyngnathus opisthopterus* (Ag.).	Volta, Pl. 58, Fig. 1.

[1] The relations of this type are discussed by Cuvier in Mém. Mus. d'Hist. Nat., Vol. I. (1815), p. 321.

85. *Pterygocephalus paradoxus* Ag.	Ag., IV. Pl. 32, Figs. 5, 6.
86. *Pycnodus apodus* (Volta).	Volta, Pl. 35, Fig. 1.
87. *Pygaeus bolcanus* (Volta).	Volta, Pl. 59; Ag., IV. Pl. 20.
88. *Rhamphosus rastrum* (Volta).	Volta, Pl. 5, Fig. 4; Ag., IV. Pl. 32, Fig. 7.
89. " " "	Volta, Pl. 75, Fig. 1.
90. *Rhamphognathus paralepoides* Ag.	Ag., V. Pl. 38, Fig. 1.
91. " *sphyraenoides* (Ag.).	Volta, Pl. 24, Fig. 3; Ag., V. Pl. 38, Fig. 2.
92. *Scatiphagus frontalis* Ag.	Ag., IV. Pl. 39, Fig. 4.
93. *Semiophorus velicans* (Blv.).	Volta, Pl. 7, Fig. 3; Ag., IV. Pl. 37.
94. " *velifer* (Volta).	Volta, Pl. 7, Fig. 1; Ag., IV. Pl. 37 *a*, Fig. 2.
95. " " "	Volta, Pl. 7, Fig. 2; Ag., IV. Pl. 37 *a*, Fig. 1.
96. *Seriola analis* (Ag.).	Volta, Pl. 69, Fig. 1.
97. " *prisca* (Ag.).	Ag., V. Pl. 11 *a*.
98. *Serranus rugosus* Heckel.	Ag., IV. Pl. 23 *b* (*supra*).
99. *Sparnodus elongatus* Ag.	Volta, Pl. 32, Fig. 1; Ag., IV. Pl. 23 *b* (*infra*).
100. " " "	Volta, Pl. 31, Fig. 1; Ag., IV. Pl. 28, Fig. 1.
101. " *microstomus* (Ag.).	Volta, Pl. 45, Fig. 3.
102. " " "	Ag., IV. Pl. 23, Figs. 1, 2.
103. *Sparnodus vulgaris* (Blv.).	Volta, Pl. 13, Fig. 1, and Pl. 17, Fig. 1; Ag., IV. Pl. 29, Fig. 2.
104. " " "	Volta, Pl. 60, Fig. 2; Ag., IV. Pl. 28, Fig. 3.
105. " " "	Volta, Pl. 73.
106. " " "	Ag., IV. Pl. 29, Fig. 1.
107. " " "	Ag., IV. Pl. 29, Fig. 3.
108. *Sphyraena bolcensis* Ag.	Volta, Pl. 62.
109. *Spinacanthus cuneiformis* (Blv.).	Volta, Pl. 13, Fig. 2; Ag., V. Pl. 39, Fig. 1.
110. *Thynnus* (?) *bolcensis* Ag.	Volta, Pl. 27.
111. " *lanceolatus* (Ag.).	Volta, Pl. 29, Fig. 1.
112. " " "	Ag., V. Pl. 23.
113. " (?) *propterygius* Ag.	Ag., V. Pl. 27.
114. *Toxotes antiquus* Ag.	Volta, Pl. 45, Fig. 1; Ag., IV. Pl. 43.
115. *Trachynotus tenuiceps* Ag.	Volta, Pl. 39, Fig. 3; Ag., V. Pl. 7, Figs. 1, 2.
116. *Trygon muricatus* (Volta).	Volta, Pl. 9, Fig. 1.
117. " " "	Volta, Pl. 9, Fig. 2.
118. *Urolophus crassicaudatus* (Blv.).	Type not figured (*de est ?*).
119. *Urosphen dubia* (Blv.).	Volta, Pl. 29, Fig. 4.

120. *Urosphen dubia* (Blv.).	Ag., IV. Pl. 35, Fig. 6.
121. *Vomeropsis triurus* (Volta).	Volta, Pl. 44, Fig. 2; Ag., V. Pl. 6.
122. " " "	Volta, Pl. 35, Fig. 3; Ag., V. Pl. 5.
123. *Xiphopterus falcatus* (Volta).	Volta, Pl. 57.
124. *Zanclus brevirostris* Ag.	Volta, Pl. 26, Fig. 2; Ag., IV. Pl. 38, Figs. 1, 2.

II. SYSTEMATIC DESCRIPTIONS.

ELASMOBRANCHII.

RAJIDAE.

Platyrhina gigantea (Blv.).

1796. *Raja torpedo* G. S. Volta, Ittiolit. Veronese, p. 521, Plate LXI.
1818. *Narcobatus giganteus* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., xxvii. p. 337.
1835. *Torpedo gigantea* L. Agassiz, Neues Jahrb., p. 297 (name only).
1843. *Torpedo gigantea* L. Agassiz, Poiss. Foss., iii. p. 382; ** iv. p. 38 (name only).
1860. *Narcine gigantea* R. Molin, Sitzungsber. Akad. Wiss. Wien, xl. p. 585.
1874. *Torpedo gigantea* A. de Zigno, Catalogo ragionato dei Pesci Fossili, p. 177.
1894. *Platyrhina gigantea* O. Jaekel, Die eocänen Selachier vom Monte Bolca, p. 108, text-fig. 19.

The holotype of this species is preserved in the Paris Museum of Natural History, and not, as stated by Baron de Zigno, in the second Gazola Collection at Verona. In its present state the disk is remarkable for its great antero-posterior elongation. De Blainville was of the opinion that this was not a character properly belonging to the specimen, but one due to deceptive appearances, a portion of the disk having become folded upon itself. O. Jaekel, without having had access to the specimen, imagined that the disk had become deformed by mechanical agencies subsequent to the death of the creature. An examination of the original leads the present writer to conclude that there is no evidence of a folding over of the edges of the disk, nor of distortion due to pressure or other causes. Although extremely probable that the lateral margin of the disk escaped fossilization, it nevertheless appears certain that the form was more elongated longitudinally than in the majority of rays.

TRYGONIDAE.

Trygon muricatus (Volta).

1796. *Raja muricata* G. S. Volta, Ittiolit. Veronese, p. 37, Plate IX. Figs. 1, 2.
1818. *Trygonobatus vulgaris* H. D. de Blainville, Nouv. Dict. d'Hist. Nat. xxvii. p. 336.

1835. *Trygon gazzolae* L. Agassiz, Neues Jahrb., p. 297 (name only).
1839. *Trygon gazzolae* L. Agassiz, Poiss. Foss., iii. p. 382**; vol. iv. p. 38 (name only).
1851. *Trygon gazzolae* J. Heckel, Sitzungsber. Akad. Wiss. Wien, vii. p. 325.
1861. *Alexandrinum*, sp. R. Molin, Sitzungsber. Akad. Wiss. Wien, xlii. p. 579.
1874. *Alexandrinum molini* A. de Zigno, Mem. R. Istit. Veneto, xviii. p. 299, Pl. XII.
1874. *Trygon gazolae* A. de Zigno, Catalogo ragionato dei Pesci Fossili, p. 180.
1894. *Trygon (Taeniura) muricatus* O. Jaekel, Die eocänen Selachier vom Monte Bolca, p. 142, Plate IV. text-fig. 32.

One can gain some idea of the difficulties attending the identification and designation of this species from the following statements of Dr. Jaekel:

"Es ist auffallend, dass eine Form, die bereits von Volta vortrefflich beschrieben und abgebildet war, und welche durch ihren reich gegliederten Skeletbau so leicht kenntlich ist, so viele nachträgliche Benennungen erfahren hat. Volta kannte und beschrieb das hier Tafel IV abgebildete Exemplar der Collection Gazola; allerdings rechnete er zu der gleichen Art, die er als *Raja muricata* bezeichnete, noch ein mit einem Stachel besetztes Schwanzfragment (*l. c.* Taf. ix. Fig. 2), welches zu *Urolophus crassicauda* [*sic*] gehort. . . . Zu den späteren Benennungen gab z. Th. die Auffindung neuer Exemplare und die Nichtberücksichtigung des vorher beschriebenen Veranlassung. So enstanden auf Grund eines Exemplares in den Pariser Sammlung die Namen *Trygonobatus vulgaris* de Blainville und *Trygon Gazzolae* Agassiz, von welchen die letztere, obwohl er ohne Beschreibung veröffentlicht wurde, sich in der Litteratur am meisten einbürgerte. Dass Molin lediglich auf Grund der distalen Stellung des Schwanzstachels eine neue Gattung *Alexandrinum* aufstellte, . . . kann nicht gerechtfertigt erscheinen" (p. 142).

The above extract is in complete accord with the views of the present writer, save in one particular, which concerns the presence in this species of the form of caudal spine attributed to it by Volta. Heckel, and following him most writers, have maintained that the original of Volta's Pl. IX. Fig. 2 does not belong to *Trygon muricatus*, but to another form of ray altogether, that now known under the name of *Urolophus crassicaudatus* (Blv.). It is probable, however, that the same form of dermal defence is common to both species. As for the original of Volta's figure, either the identical specimen, or one so closely resembling it as to be indistinguishable from it, is preserved in the Paris Museum of Natural History; and this is seen very clearly to belong to a complete individual of *Trygon muricatus*.

Urolophus crassicaudatus (Blv.).

1818. *Trygonobatus crassicaudatus* H. d. de Blainville, Nouv. Dict. d'Hist. Nat. xxvii. p. 337.
1835. *Trygon oblongus* L. Agassiz, Neues Jahrb., p. 297.
Trygon oblongus L. Agassiz, Poiss. Foss., iii. p. 382, **, iv. p. 38.
1851. *Trygon brevicauda* J. Heckel, Sitzungsber. Akad. Wiss. Wien, vii. p. 324.
1853. *Urolophus princeps* J. Heckel, Sitzungsber. Akad. Wissen. Wien, xi. p. 122.

1861. *Taeniura kneri* R. Molin, Sitzungsber. Akad. Wiss. Wien, xlii. p. 581.
1863. *Urolophus princeps* Kner und Steindachner, Denkschr. Akad. Wiss. Wien, xxi. p. 32, Plate VI. Fig. 2.
1874. *Trygon oblongus* A. de Zigno, Catalogo Ragionato dei Pesci Fossili, p. 181.
1874. *Taeniura kneri* A. de Zigno, *ibid.*, p. 182.
1874. *Urolophus princeps* A. de Zigno, *ibid.*, p. 183.
1889. *Taeniura kneri* A. S. Woodward, Cat. Fossil Fishes Brit. Mus., pt. i. p. 153.
1894. *Urolophus crassicauda* O. Jaekel, Die eocänen Selachier vom Monte Bolca, p. 148, Plate V.

It seems desirable to give the complete synonymy of this species, as there is no possible reason for doubting that all of the rays described under the various names cited above belong to a single species. There is no specimen at the Paris Museum which can be certainly identified as the type either of de Blainville's *Trygonobatus crassicaudatus*, or of Agassiz's *Trygon oblongus*.

CARCHARIIDAE.

Carcharias (Scoliodon) cuvieri (Agassiz).

(**Text-figure** *4.*)

1796. *Squalus carcharias* G. S. Volta, Ittiolit. Veronese, p. 10, Plate III. Fig. 1.
1807. *Squalus vulpes* Scortegagna, F. O., Memoria epistolare al Sig. Faujas-St.-Fond.
1807. *Squalus carcharias* G. Gazola, Lettera al Sig. Scortegagna, &c.
1818. *Squalus innominatus* (*errore*) H. D. de Blainville, Nouv. Dict. d'Hist. Nat. xxviii. p. 336.
1835. *Galeus cuvieri* L. Agassiz, Neues Jahrb., p. 291.
1839. *Galeus cuvieri* L. Agassiz, Poiss. Foss., iv. p. 38.
1860. *Protogaleus minor* (*pars*) R. Molin, Sitzungsber. Akad. Wiss. Wien, xl. p. 583.
1874. *Alopiopsis cuvieri* (*pars*) A. de Zigno, Catalogo ragionato dei Pesci Fossili, p. 174.
1894. *Galeus cuvieri* O. Jaekel, Die eocänen Selachier vom Monte Bolca, p. 172, text-fig. 38.

The holotype of this species forms part of the Gazola Collection in Paris, and another specimen slightly smaller than the type is preserved in the University of Padua Museum. An outline figure of the latter is given by Jaekel, and likewise the following description: —

"Was nun schliesslich das kleinere, vorstehend abgebildete Exemplar der Paduaner Sammlung betrifft, so ist dasselbe fast vollständig erhalten, also wesentlich besser, als das von Volta abgebildete und von Agassiz als *Galeus cuvieri* bezeichnete. . . . Die Brustflossen sind schlank, fast sichelformig rückwarts gekrümmt."

Regarding the type-specimen in the Paris Museum the same author remarks that the rostral region is incompletely preserved, and "von den Flossen

sind nur die beiden Brustflossen deutlich." A little further on, however, he says: "Die erste Rückenflosse ist auch bei dem Pariser Exemplar an derselben Stelle angedeutet, wo sie bei dem hier abgebildeten sitzt, nämlich unmittelbar über dem Hinterrand der Brustflossen. Auch die zweite Dorsalis und die Analis scheinen bei dem Pariser Stück an der gleichen Körperstelle, wie an dem Paduaner, übereinander zu stehen. . . . Ueber die Form der Schuppen und sonstigen Einzelheiten konnte ich leider an dem Pariser Stück keine zuverlässige Beobachtung anstellen" (p. 174).

The present writer has not been able to verify the above description in all particulars, but on the other hand has found it possible to observe some details not previously made known.

The specimen, by the way, is preserved on a single slab, and the catalogue of the Museum does not show that it ever existed in counterpart, although the contrary is affirmed by Jaekel. The anterior third of the trunk lies squarely on its back in the matrix, the first dorsal fin being thus wholly or for the

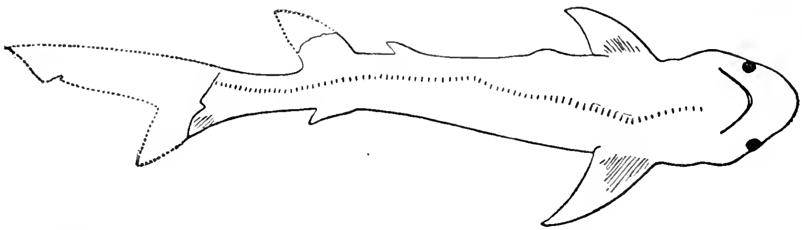


FIG. *A*. Type-specimen of *Carcharias* (*Scoliodon*) *cuvieri* (Ag.). × $\frac{1}{10}$. Extremities of the dorsal and caudal fins hypothetically restored.

most part concealed. The remainder of the trunk is visible from the lateral aspect, and the fins which it exhibits are the posterior dorsal, anal, and a portion of the lower lobe of the caudal, as indicated in the accompanying Figure *A*. A small triangular mass of scales lying immediately in front of the posterior dorsal may perhaps be interpreted as a ruptured portion of the shagreen, or possibly even as the displaced tip of the anterior dorsal.

The shagreen is very excellently preserved over various portions of the body, the form and structure of the individual scales appearing as distinct as in life. The shagreen granules agree so perfectly with those of the recent Scoliodon that no further description is necessary, and the same is true of the dentition. A number of the teeth are preserved in their natural position in the mouth region, and all exhibit very clearly the inclined triangular crown with smooth edges characteristic of Scoliodon. It will be seen that the identification which is here made of this shark as a species of Scoliodon is in accordance with all the characters, except that the rostrum appears to have been rather less prolonged. In the above text-figure, the posterior dorsal and caudal fins have been hypothetically restored.

Altogether seventeen species of elasmobranchs are known from the Monte Bolca horizon, a list of which is subjoined:

SPECIES OF ELASMOBRANCHS FROM MONTE BOLCA.

1. *Rhinobatis zignii* (Heckel).
2. " *primaevus* Zigno.
3. *Platyrhina bolcensis* (Heckel).
4. " *egertoni* Zigno.
5. " *gigantea* (Blv.).
6. *Narcine molini* Jaekel.
7. *Trygon muricatus* (Volta).
8. " *zignii* (Molin).
9. *Urolophus crassicaudatus* (Blv.).
10. *Promyliobatis gazolae* (Zigno).
11. *Lamna vincenti* Winkler.
12. *Odontaspis hopei* Ag.
13. *Carcharodon auriculatus* (Blv.).
14. *Pseudogaleus voltai* Jaekel.
15. *Alopiopsis plejodon* Lioy.
16. *Carcharias (Scoliodon) cuvieri* (Ag.).
17. *Mesiteia emiliae* Kramb.

TELEOSTOMI.

ACTINOPTERYGII.

ALBULIDAE.

MONOPTERUS VOLTA.

Trunk elongated oval and laterally compressed. Head relatively short, with steep frontal profile; opercular bones well developed. Vertebrae at least 60 in number, half of them being caudal. Length of anterior pectoral fin-ray exceeding maximum depth of trunk; pelvic fins minute, situated nearer the anal than the pectoral pair. Anal placed opposite the dorsal, and rising into an acuminate lobe in front. Caudal very deeply forked, with a scaly lamella extending over the middle of the tail at the base. Mouth opening small, a series of conical teeth present along the margin of the jaws, and a series of hemispherical crushing teeth placed further back.

Monopterus gigas VOLTA.

1796. *Monopteros gigas* G. S. Volta, Ittiolit. Veronese, p. 191, Plate XLVII.
1818. *Monopteros gigas* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., xxvii. p. 357.
1835. *Platinx gigas* L. Agassiz, Neues Jahrb., p. 304.
1838–44. *Platinx gigas* L. Agassiz, Poiss. Foss., v. pt. 2, p. 126.
1874. *Platinx gigas* A. de Zigno, Catalogo ragionato dei Pesci Fossili, p. 151.

The removal of this species from the genus Platinx, and its transfer to the vicinity of Chanos, amongst the Albulidae, appears warranted by the presence of numerous hemispherical crushing teeth in the pharyngeal region, and by the

structure of the caudal and other fins. The dorsal and anal are situated opposite each other, and consist each of 20 rays. The caudal is short and much expanded, covered with a scaly lamella along the middle at its base, and the distance between the extremities of its lobes exceeds the maximum depth of the trunk. All of the fins have the foremost ray covered with a finely rugose dermal layer, and the anterior pectoral fin-ray is as much enlarged and elongated as in certain Osteoglossidae and Chirocentridae. This species, of which several examples are known, attains a total length of about 80 cm.

SCOPELIDAE.

Holosteus esocinus Agassiz.

1838–44. *Holosteus esocinus* L. Agassiz, Poiss. Foss., v. pt. 2, p. 85, Plate XLIII. Fig. 5.

1856. *Holosteus esocinus* H. G. Bronn, Lethaea Geognostica, p. 683, Plate XLII.[3] Fig. 8.

1874. *Holosteus esocinus* A. de Zigno, Catalogo ragionato dei Pesci Fossili, p. 140.

The holotype and only known example of this species is an imperfectly preserved fish belonging to the Gazola Collection of the Paris Museum. It bears on the reverse the following MS. inscription in Agassiz's handwriting: "Cette plaque est évidemment composée de pièces incoherentes, surtout de la partie antérieure de la dorsale, et vers le front de la tête; cependant la colonne vertebrale indique un poisson d'un genre nouveau voisin de *Belone*."

An examination of the specimen shows that the vertebral column is intact from the occiput at least as far as the insertion of the dorsal fin, the latter being unquestionably preserved in its natural position. It is evident that the triangular piece intended to represent the interneurals supporting the dorsal does not belong to this fish, and the same remark applies also to another fragment introduced in advance of the dorsal, which was properly recognized by Agassiz as "n'étant q'une fausse dorsale." Although the authenticity of the anal itself is doubtful, its position is shown by the presence of fin-supports to be opposite the dorsal. Very little of the portion posterior to the anal fin can be regarded as other than a factitious mosaic.

CARANGIDAE.

Caranx primaevus, sp. nov.

(Plate 1, Fig. 4; Text-fig. *B*.)

A small species attaining a total length of about 10 cm. Head with opercular apparatus contained slightly less than $3\frac{1}{2}$ times in the total length to base of caudal fin. Trunk laterally compressed, elongated, regularly fusiform. An-

terior dorsal fin with about 8 spines of moderate length, closely followed by the low second dorsal with about 20 soft rays. Anal fin opposed to the posterior dorsal, and apparently of equal extent, preceded by two short and separate anal spines. Dorsal and anal finlets not observed. Scales thin and small. Lateral line with well-developed scutes along its entire length, the line arching upward and the scutes becoming shorter anteriorly; number of scutes about 65.

The unique individual upon which the above description is based exists in counterpart, and details taken from both halves have been combined in

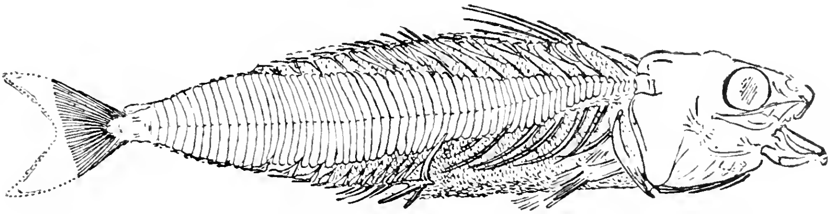


FIG. *B*. *Caranx primaevus*, sp. nov. × 1/1.

the adjoining Figure *B*. This is the earliest recorded appearance of the genus in geological history, the half-dozen fossil species that are known being confined to the Oligocene and Miocene. Amongst the latter *C. ovalis*, which is imperfectly known, seems to have resembled the present species in general outline, and amongst modern forms the species commonly referred to "*Trachurus*" (e.g., *Caranx trachurus* and *C. picturatus*) present the same peculiarity of having scutes developed along the entire length of the lateral line.

The type-specimen, which is from Monte Bolca, is preserved in the Museum of Comparative Zoölogy.

LABRIDAE.

Symphodus szajnochae (ZIGNO).

(Plate 1, Fig. 5.)

1887. *Crenilabrus szajnochae* A. de Zigno, Mem. R. Istit. Veneto, xxiii. p. 17, Fig. 3.

Besides the holotype of this species, which is small and imperfectly preserved, no other examples have come to light until recently, when one was acquired for the Museum of Comparative Zoölogy, and another for the Carnegie Museum at Pittsburgh. The individual belonging to the Cambridge collection is preserved in counterpart, and is interesting for the additional information which it affords in regard to certain structural details.

This example has a total length of 10 cm. to the base of the caudal fin, and in this distance the head with opercular apparatus is contained four times.

The preoperculum is strongly serrated, its posterior border being produced into very prominent spines. The marginal teeth are conical and arranged in single series, no pharyngeal teeth being observed. The vertebrae are about 25 in number, of which 14 are caudal. The dorsal fin is much extended, with about 26 rays, and of these 11 are spinous. The caudal is composed of 17 principal rays, there being one more in the upper than in the lower lobe, and these are preceded both above and below by four or five spinelets. The anal appears to be formed of about eight rays in addition to the spines, but their number cannot be accurately counted. There are at least eight branchiostegal rays. Evidence of the former extension of the scales over the opercular bones and cheeks is not apparent in the present condition of the specimen, nor in fact is it ordinarily to be expected amongst fossils. The scales are thin, ctenoidal, and very strongly pectinated.

Crenilabrus was separated by Cuvier from Labrus as a distinct genus on account of its having a serrated preoperculum, but it has been shown by D. S. Jordan in his Review of Labroid Fishes [1] that the form is identical with the earlier described Symphodus of Rafinesque.

CHAETODONTIDAE.

PYGAEUS Agassiz.

To this imperfectly known extinct genus have been referred half a dozen species from the Bolca Eocene, and two from the Lower Miocene of Chiavon, Vicentin. The type species is *P. bolcanus* (Volta), renamed *P. gigas* by Agassiz. This is a large form, attaining a total length of about 35 cm., the remaining species being very much smaller, and included by Agassiz only provisionally in the same genus with the type. It appeared to Agassiz that the smaller forms constituted a group by themselves, typified by *P. coleanus*, but passing over into the group of larger forms through the intermediate *P. oblongus*. Concerning the advisability of subdividing the genus, Agassiz remarks as follows: "Il faudra donc probablement démembrer un jour ces espèces et en faire autant des genres qu'on y reconnaîtra de types differents, en les étudiant d'une manière plus complète; ce qui sera d'autant plus difficile que les Pygées sont fort rares dans les collections."

There are in addition to the small number of forms known to Agassiz two other species represented by a solitary individual each, which are evidently closely akin to *Pygaeus bolcanus*, although possessing more finely divided vertical fins. These are the so-called *Acanthurus gazolae* Massalongo [2] and *A. gaudryi* de Zigno,[3] from the Bolca Eocene, whose true position amongst

[1] Jordan, D. S., A Review of the Labroid Fishes of America and Europe, Rept. U. S. Fish Comm. for 1887, pp. 559–699, 1891.

[2] Specimen Photogr. Anim. Foss. Agr. Veron., 1859, p. 26.

[3] Atti R. Istit. Veneto, xxiii. 1887, p. 14, Fig. 2.

Chaetodonts has already been suspected by Smith Woodward. It is probable that they represent types of distinct genera, but for the present they may be most conveniently included within the limits of Pygaeus, as purposely extended by Agassiz. It is evident that some of these forms are closely related to modern Acanthuridae, the chief differences consisting in the great development of the dorsal spines, and the fact that the maxilla and premaxilla are distinct. The latter condition is alone sufficient to warrant the retention of these larger species of Pygaeus amongst the Chaetodontidae, rather than amongst the Acanthuridae, or so-called "Acronuridae" of Günther, and Teuthidae of Jordan. On the other hand, the teeth are much stouter than in living Chaetodonts.

We have now to offer the description of a new species of Pygaeus, as construed in its broader sense, no division of this genus being at present attempted.[1] The type-specimen formerly belonged to the Marchese di Canossa Collection, a part of which was purchased some months ago for the Museum of Comparative Zoölogy. The choice of a specific title has been determined by the desire to commemorate the labors of the master in this field, his name not being similarly associated with any other member of the Bolca fauna.

Pygaeus agassizii, sp. nov.

(Plate 2.)

D. 10 + 9; A. 5 + 8; V. 5; P. 17 or 18.

A comparatively large species, attaining a total length of about 19 cm. Maximum depth of trunk contained twice, and length of head with opercular apparatus three times in the total length to base of caudal fin. Dorsal fin arising immediately behind the occiput and extending as far as the caudal pedicle with ten subequal spines and nine articulated rays, the latter not longer than the former, and not produced into an acute lobe in front. Anal spines gradually increasing in length and stoutness from the first onward, the fifth equalling the foremost articulated ray in length, and longitudinally striated. Articulated portion of the anal corresponding in size and position to the articulated dorsal. Abdominal vertebrae 10, caudal 13. Large incisiform teeth present in front, gradually diminishing in size posteriorly, apparently in single series; maxilla and premaxilla clearly separate. Scales small, those of the posterior part of the body in the form of shagreen-like calcifications and tubercles. Neural spines of abdominal region and all of the interspinous bones much expanded; pelvic bones strongly developed. No lateral caudal spines.

[1] The writer is indebted to President Jordan, than whom is no higher authority, for the suggestion that "*Pygaeus*, and possibly *Apostasis* also, should be taken as representing a distinct family, which would occupy a more central position near the common ancestry of *Acanthuridae Chaetodontidae*, and *Siganus* (*Teuthis*)" (*litt.*, May, 1904).

The general outline of body in this species is more suggestive of Acanthurus than Pygaeus, but the fin-structure is wholly in accord with the latter genus. The development of the spinous dorsal is about equal to that of the type species of Pygaeus, but the articulated dorsal is less strongly developed. This is a character of specific importance, and its variation amongst different forms belonging to the same general group is indicated by the following formulae :

Pygaeus bolcanus	D. 10 or 12 + 20 (*fide* Agassiz).
" *agassizii*	D. 10 + 9 ; A. 5 + 8.
" *nobilis*	D. 12 + 12 ; A. 3 + 12.
" *coleanus*	D. 14 + 15 ; A. 9 + 11.
Acanthurus gaudryi	D. 7 + 28 ; A. 3 + 25.
" *tenuis*	D. 9 + 21 ; A. 3 + 19.

LOPHIIDAE.

Histionotophorus, nomen nov.

[*Histiocephalus* A. de Zigno, 1887.]

The name proposed for this genus by Baron de Zigno is not only inappropriate but preoccupied, Diesing having applied it to a genus of Vermes in 1851. The title Histiocephalus may therefore be discarded in favor of *Histionotophorus*, which is bestowed in allusion to the sail-like median fin extending along the back.

Histionotophorus bassani (ZIGNO).

(Plate 1, Figs. 1-3 ; Text-fig. *C*.)

1887. *Histiocephalus bassani* A. de Zigno, Mem. R. Istit. Veneto, xxiii. p. 31, Fig. 9.

D. I – I – I + 13 ; C. 8 ; A. 9 ; V. 7 ; P. 6.

A comparatively small pediculate species attaining a total length to the base of the caudal fin of about 6 cm. Mouth oblique, maxillary extending far downward, dentary thickened, jaws with cardiform teeth, skin naked. Anterior dorsal of three separated tentacle-like spines on the head, posterior dorsal high, much extended, with thirteen articulated rays, the fin-membrane stiffened at the base with small spiniform calcifications. Pectoral members situated immediately above the origin of the anal fin, their short rays directed vertically, and supported by extremely long pseudobrachia, which are apparently composed of two actinosts. Number of vertebrae apparently not more than 18 (according to de Zigno, however, there are 22 in the type, 10 abdominal and 12 caudal).

Three specimens answering to the above description, two of them in counterpart, are preserved in the Museum of Comparative Zoölogy, and their princi-

pal characters are combined in the accompanying text-figure, so far as they are observable. There is little room for doubt that these interesting and rare pediculates are identical with the species described by Baron de Zigno under the name of *Histiocephalus bassani*, although the type-specimen is so imperfectly preserved that his description is at variance in some points with the one given above, and the affinities of the type have remained more or less obscure. The latter, indeed, was referred to the Scorpaenidae by Dr. A. S. Woodward in his Catalogue of Fossil Fishes in the British Museum. The characteristic pectoral members are not shown in de Zigno's illustration of this form, and the head is much disfigured; as for a supposed membrane supported by the cephalic spines (to which the name Histiocephalus alludes), no indication is afforded by the new material that such a structure existed. An interesting fact to be noted is the close correspondence existing between the fin-formulae of the fossil and recent species. In the common Angler, *Lophius*

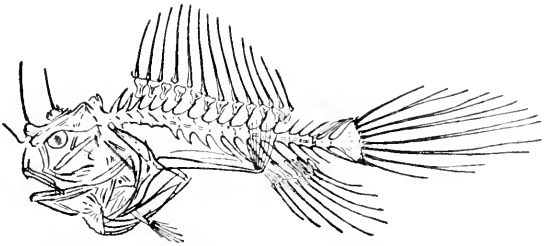


FIG. *C.* *Histionotophorus bassani* (de Zigno). × 1/1. A composite drawing based upon three individuals belonging to the Mus. Comp. Zoöl.

piscatorius, for instance, as well as in the form under discussion, the first and second dorsal together comprise 13 rays, and the number of rays belonging to the caudal, anal, and ventral fins is identical in both species.

It is to be regretted that the cranial osteology is not more clearly displayed, as it would be interesting to compare the various degrees of modification exhibited by the Eocene and modern pediculates. The recent genus Corynolophus exhibits a similar thickening of the dentary and other bones of the lower jaw, and another resemblance is seen in the construction of the premaxillaries, which are probably movable, but further than this we cannot go. Attention should be called, however, to the remarkable fact of a type of fish-life appearing suddenly in the Eocene, already highly modified, without any known predecessors nor any that can be plausibly conjectured, but which persists after its first introduction essentially unchanged until modern times.

GYMNODONTIDAE.

Diodon erinaceus Agassiz.

(Text-figure *D*.)

1844. *Diodon erinaceus* L. Agassiz, Poiss. Foss., ii. pt. ii. p. 274.
1859. *Diodon erinaceus* A. B. Massalongo, Specimen Photogr. Anim. Foss. Agr. Veron., p. 21, Plate XII. Fig. 2.
1874. *Diodon erinaceus* A. de Zigno, Catalogo ragionato dei Pesci Fossili, p. 163.
1876. *Diodon erinaceus* F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., iii. p. 189.
1901. *Diodon erinaceus* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., pt. iv. p. 572.

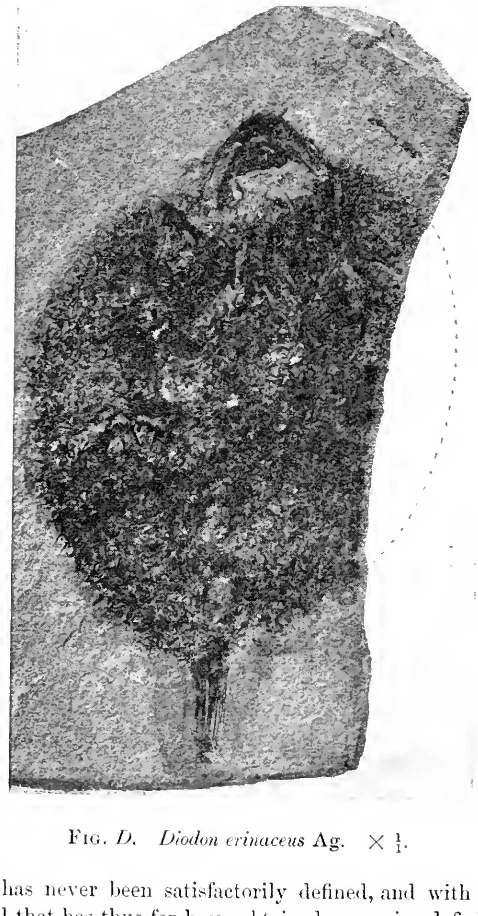


Fig. *D*. *Diodon erinaceus* Ag. $\times \frac{1}{1}$.

This species has never been satisfactorily defined, and with the extremely limited material that has thus far been obtained, a precise definition is not yet

possible. Agassiz's sole description consists in the statement that it is "une espèce de trois pouces de long, remarquable par sa forme ovale et par ses piquants courts, robustes et assez clair-semés." Of the type-specimen, now preserved in the British Museum, Dr. Woodward states that it is exposed from the ventral aspect, has the dentition much obscured, and "no fins are seen except part of the caudal. The largest and most slender spines are at the sides of the middle of the trunk."

The type-specimen has never been figured, and the species is so little known that it seems desirable to furnish an illustration of a specimen closely resembling the type, which has recently been secured by the Museum of Comparative Zoölogy. This is shown from the ventral aspect in the adjoining text-figure 4, and it will be seen that scarcely any differences are to be noted between it and the so-called "*Enneodon echinus*" of Heckel. In the latter, according to this author, "der Oberkiefer ist mit sieben kleinen Zahnplatten besetzt, die gleich einer Reihe flacher Schneidezähne dicht an einander stehen." There are some obscure indications that separate teeth were also present around the margin of the upper jaw in *Diodon erinaceus*, but as this cannot be absolutely demonstrated at present, it is not deemed advisable to unite these two species. The lower dental plate is well shown from the inferior aspect in the Cambridge specimen, and does not appear to have been divided by a median longitudinal suture. Pelvic fins are not observable, nor has the writer been able to detect them in any specimen of *D. tenuispinus* from Monte Bolca thus far examined by him. An example of this species so closely resembling the type as to have been confused with it by some writers is treasured amongst the splendid collection belonging to the Paris Museum of Natural History. For the exceptional favors and facilities enjoyed at the hands of M. Albert Gaudry and M. Boule during his study of this collection the past year, the writer finds it difficult to express his deep sense of obligation and gratitude.

EXPLANATION OF PLATES.

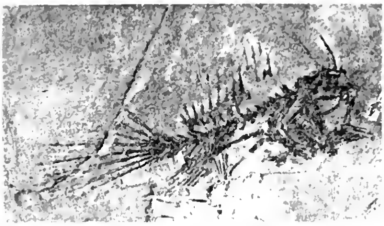
All figures are of the natural size, and the originals are preserved in the Museum of Comparative Zoölogy.

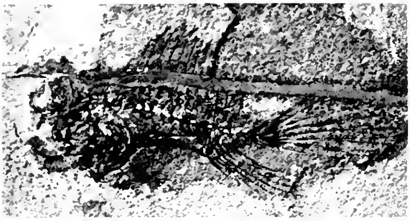
PLATE 1.

Figs. 1–3. *Histionotophorus bassani* (Zigno). Upper Eocene; Monte Bolca. Figs. 1 and 1 *a* are counterparts of the same specimen.
Fig. 4. *Caranx primaevus*, sp. nov. Upper Eocene; Monte Bolca.
Fig. 5. *Symphodus szajnochae* (Zigno). Upper Eocene; Monte Bolca.

PLATE 2.

Pygaeus agassizii, sp. nov. Upper Eocene; Monte Bolca (*ex* Canossa Collection).





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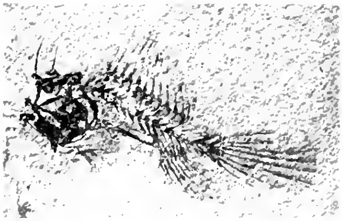

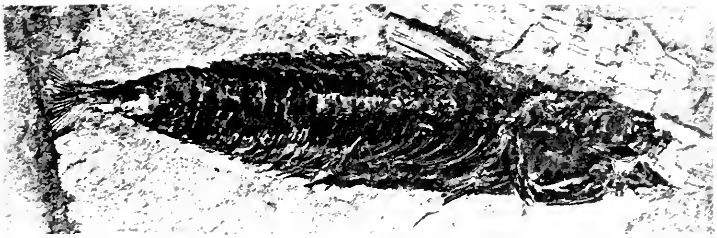

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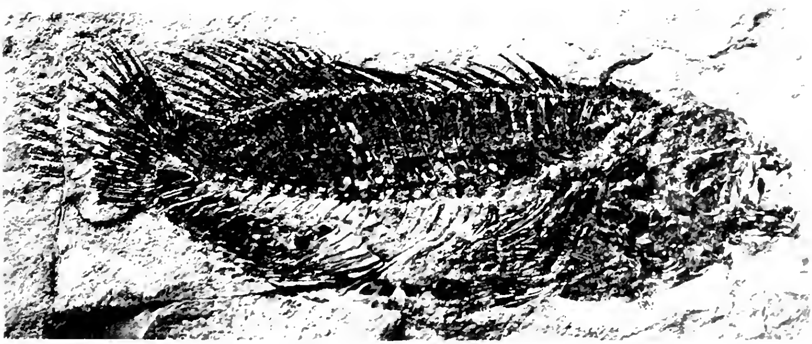

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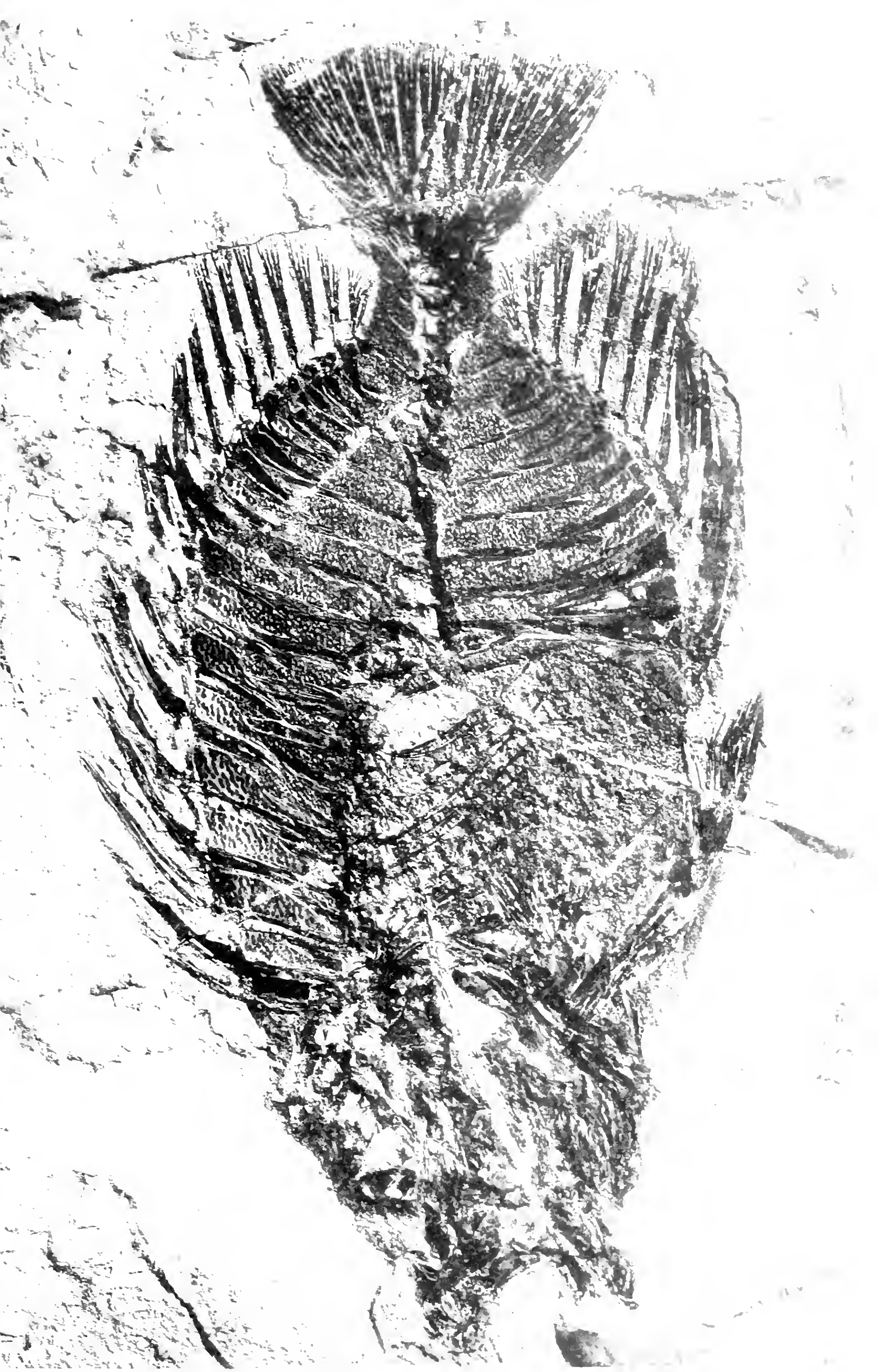

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S Coast Survey Steamer "Blake" as follows: —

E. EHLERS. The Annelids of the "Blake."
C. HARTLAUB. The Comatulæ of the "Blake," with 15 Plates.
H. LUDWIG. The Genus Pentacrinus.
A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Illustrations of North American MARINE INVERTEBRATES, from Drawings by BURKHARDT, SONREL, and A. AGASSIZ, prepared under the direction of L. AGASSIZ.

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E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER The Alcyonarians.
M. P. A. TRAUSTEDT. The Salpidæ and Doliolidæ.
H. B. WARD. The Sipunculids.
H. V. WILSON. The Sponges.
W. McM WOODWORTH. The Nemerteans.
" The Annelids.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to XLI., and also Vol. XLIV.; of the Memoirs, Vols. I. to XXIV., and also Vols. XXVIII. and XXIX.

Vols. XLII., XLIII., XLV., XLVI., and XLVII. of the BULLETIN, and Vols. XXV., XXVI., XXVII., XXX., and XXXI. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Professors and Assistants of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

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Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, in charge of Professor N. S. Shaler.

These publications are issued in numbers at irregular intervals; one volume of the Bulletin (8vo) and half a volume of the Memoirs (4to) usually appear annually. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Librarian of the Museum of Comparative Zoölogy, Cambridge, Mass.

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Bulletin of the Museum of Comparative Zoology

AT HARVARD COLLEGE

VOL. XLVI. No. 2.

MALDIVE CEPHALOCHORDATES,

WITH THE DESCRIPTION OF A NEW SPECIES FROM FLORIDA.

BY G. H. PARKER.

WITH TWO PLATES.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

NOVEMBER, 1904.

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No. 2. — *Maldive Cephalochordates, with the Description of a New Species from Florida.* By G. H. Parker.

Introduction.

Through the kindness of Mr. Alexander Agassiz, to whom my thanks are due, I have had the privilege of studying the cephalochordates collected by him in his recent expedition to the Maldive Islands. These consisted of material from three localities. At Timarafuri, Kolumadulu Atoll, a single specimen of the rare Branchiostoma pelagicum Günther was taken in the net between one hundred and fifty fathoms and the surface: at Nalandu, Miladummadulu Atoll, a single specimen of a new species of Heteropleuron was dredged in twenty-four fathoms; and at Hanimadu, Tiladummati Atoll, the dredge brought up from sixteen fathoms twenty-one specimens as follows: twelve Heteropleuron maldivense Cooper, two specimens of a new species of Heteropleuron, and seven specimens of a new species closely related to Asymmetron lucayanum Andrews. The exact positions of these localities are well shown in the chart accompanying Mr. Agassiz's (**1903**, Plate 1) account of his voyage.

In addition to this material I have also studied that in the collections of the Museum of Comparative Zoölogy and of the United States National Museum. In the former I found seven specimens of a new species of Asymmetron from the coast of Florida. A description of this species is included in the present paper.

I am indebted to the officers of the National Museum and of the Museum of Comparative Zoölogy, especially to my friend Dr. W. McM. Woodworth, for the use of the collections under their charge.

Description of Species.

While it is perhaps premature, in view of the rapidly increasing number of species, to discuss at any length the classification of the cephalochordates, a survey of the recent literature on the subject shows that the species thus far known fall more or less naturally into three groups, which have at least the taxonomic value of genera.

The first of these is Costa's original genus Branchiostoma, which, though somewhat restricted by new definitions, has been retained by Kirkaldy

(**1895**), Gill (**1895**), Willey (**1901**), and Tattersall (**1903**[a]), and is defined by all excepting Kirkaldy for the inclusion of symmetrical species only.

The second is Andrew's Asymmetron, which was accepted in its original form by Kirkaldy (**1895**) and by Gill (**1895**), but expanded by Tattersall (**1903**[a]) to include all unsymmetrical species, whether they possessed a urostyloid process or not.

The third is Kirkaldy's subgenus Heteropleuron, which was raised by Willey (**1901**) to generic value for the reception of all unsymmetrical species, including those originally put under Asymmetron.

These three genera may be briefly defined as follows:

1. *Branchiostoma.* — Symmetrical cephalochordates in which the right and left metapleural folds terminate just behind the anus and the gonads form two lateral series.

2. *Heteropleuron.* — Unsymmetrical cephalochordates in which the left metapleural fold terminates just behind the anus, and the right one is continuous with the median ventral fin; the gonads form a single series on the right side; and a urostyloid process is not present.

3. *Asymmetron.* — Unsymmetrical cephalochordates in which the left metapleural fold terminates just behind the anus and the right one is continuous with the median ventral fin; the gonads form a single series on the right side; and a well developed urostyloid process is present.

As already indicated, species representing all three genera were found by Mr. Agassiz in the Maldives, and their descriptions follow.

Branchiostoma pelagicum GÜNTHER.

Günther, 1889, p. 43.

Plate 1, Figs. 1, 2.

A single specimen of this somewhat rare species was taken in the net between one hundred and fifty fathoms and the surface at Timarafuri, Kolumadulu Atoll. This species was originally described from a single specimen taken by the "Challenger" a few degrees north of Honolulu in the Pacific. A second specimen obtained by Mr. J. J. Lister, in the Indian Ocean midway between Madagascar and Australia, was reported on by Cooper (**1903**, p. 352) in his account of the Maldive and Laccadive cephalochordates. Finally six specimens formed the basis of an account of this species by Tattersall (**1903**[b], p. 214); all six were taken by tow-net in the Indian Ocean, one about halfway between Perim and the Maldives, and the other five between the Maldives and the Gulf of Manaar. Notwithstanding these several catches, all three lots of material were reported as poorly preserved, and consequently the best description of this species that could be compiled is still defective in several important particulars.

The specimen obtained by Mr. Agassiz is exceptionally well preserved, and the following notes based upon an examination of it are intended to supplement former descriptions.

The length of the specimen is 9 mm. and its depth 0.8 mm., being slightly smaller than the "Challenger" specimen, though having almost exactly the same proportions. Cooper's specimen had the considerable length of 21 mm., though, as his figure shows, its depth was proportionally as great as that of the "Challenger" specimen. Tattersall's largest specimen was 8.5 mm. long and 1 mm. deep, thus agreeing fairly well with the measurements of the small individuals already given. Tattersall's drawing (**1903**[b], Fig. 16), however, represents, probably by mistake, a more slender animal. Notwithstanding the slight differences in the dimensions of the various specimens, they probably all belong to one species.

The fins in the specimen taken by Mr. Agassiz were in perfect preservation. The caudal fin (Plate **1**, Fig. 2) is oval in outline and almost exactly symmetrical dorsoventrally. The chorda extends through its major axis, and ends close to its posterior edge. The fin dorsally and ventrally is marked with numerous delicate radiating striae.

Dorsally the caudal is continuous with a dorsal fin, which can be followed to the anterior end of the animal. Near the tail (Fig. 2) it is moderately high, but it gradually becomes lower and lower, till near the anterior end (Fig. 1) it is about one-third as high as at its posterior limit. In the posterior region a row of low fin-ray chambers can be seen (Fig. 2). These increase in height, and near the middle of the trunk reach the outer edge of the fin. At the anterior end they rapidly diminish in height, and cease near the eye-spot (Fig. 1). They contain no fin-rays.

A low ventral fin without fin-ray chambers connects the caudal fin with the right metapleural fold.

Anteriorly the dorsal fin is continuous with a rostral fin (Fig. 1) which expands ventrally and posteriorly to join the buccal hood on the left side.

The number of myotomes in the specimen under examination is sixty-seven, corresponding in this respect exactly with the "Challenger" specimen. Cooper's specimen contained at least sixty, and Tattersall's sixty-five, though, as the authors state, neither of these counts can be relied upon as accurate because of the poor state of the material.

The myotome formula for this species had been provisionally stated by Kirkaldy (**1895**, p. 320) as $36 + 16 + 15 = 67$. This was based upon a tentative statement by Günther (**1889**, p. 43), in whose specimen the atriopore could not be identified with certainty. In our specimen the atriopore and anus were distinctly visible, and the myotome formula proved to be $46 + 10 + 11 = 67$.

The notochord, which is well developed, reaches from very near the anterior edge of the rostral fin almost to the posterior limit of the caudal. At both ends it projects well beyond the myotomes.

The nerve tube contains in its anterior end a well developed eye-spot and,

beginning at the third myotome and extending almost to the posterior end, a series of smaller spots in groups irregularly twice as numerous as the myotomes.

The gonads form two series, one right and one left, though, as intimated by Günther (**1889**, p. 44), they are often so closely pressed together near the median plane that they there seem to form a single median row. The presence of a double row of gonads places this species unquestionably in the genus Branchiostoma.

The number of gonads on each side was thirty-three, and the series ranged from the first to about the twenty-ninth myotome instead of the twenty-sixth, as in the "Challenger" specimen. Our specimen is probably a male, though the gonads were not sufficiently mature to allow this determination to be made with certainty.

I can confirm the statement of most previous writers that oral cirri are absent. I have also been unable to find any evidence of branchial apparatus, and I agree with Cooper (**1903**, p. 353) that if this apparatus is present at all, it must be very limited in extent. Possibly the small size and flattened form of this species, which must place very near the surface all the living substance in need of oxygen, may have been acquired in connection with a gradual loss of specialized respiratory organs in much the same way that many of our smaller salamanders seem to have lost their lungs.

Heteropleuron maldivense Cooper.

Cooper, 1903, p. 349.

Twelve specimens of this recently described species were dredged in sixteen fathoms of water at Hanimadu, Tiladummati Atoll. They agreed in all particulars with the very full account of this species given by Cooper. The more important structural relations as shown in three of the specimens are given in Table I.

TABLE 1.

Structural Characteristics, etc., of H. maldivense.

No. of Specimen.	Length in mm.	Sex.	No. of Gonads.	Myotome Formula.
1	19	♂	23	42 + 16 + 12 = 70
2	17.5	♀	24	43 + 16 + 11 = 70
3	16	♀	23	43 + 16 + 12 = 71
Mode			25	45 + 16 + 12 = 73
Range			8	5 4 4 7

These records agree fairly well with those tabulated for this species by Punnett (**1903**, p. 363), from whose table the modes and ranges at the base of Table I. are taken.

Heteropleuron agassizii, sp. nov.

Plate 2, Fig. 5.

One specimen of this species was dredged in twenty-four fathoms of water at Malandu, Miladummadulu Atoll. It is rather elongated, measuring 27 mm. in length by 3 mm. in depth. The dorsal fin is of almost uniform height throughout. From the anal region to a point a little in advance of the anterior end of the nerve tube, it contains fin-ray chambers to the number of four or five to a myotome. In the anterior and posterior regions these fail to reach the free edge of the fin, but in the trunk region they meet the edge. The most anterior three chambers are without fin-rays, which are present in all the more posterior chambers to a point about midway between the atriopore and the anus. From this point posteriorly, only faint traces of fin-rays are here and there observable, and even these disappear as the caudal region is approached. Never more than one fin-ray is present in a chamber. Often in the anterior region and sometimes posteriorly the fin-rays may reach to half the height of the fin, but in most places they are only about one-fourth this height. Anteriorly the dorsal fin is continuous with the rostral. Posteriorly it passes into the simple inconspicuous caudal fin which in turn is continuous with the ventral. The ventral fin has much less height than that part of the dorsal fin opposite to it, and is without fin-rays or fin-ray chambers.

The myotome formula is $45 + 15 + 10 = 70$.

The chorda is stout and almost reaches the anterior and posterior limits of the body, projecting well beyond the myotomes in both directions.

The nerve tube has a faint anterior eye-spot followed by a series of smaller spots reaching from the third to the last myotome, and showing the usual tendency to fall into two groups for each myotome.

The gonads form a single series on the right side, and are twenty-four in number. They extend from the seventeenth to the forty-first myotome. The specimen is a female.

The oral region is so contracted that it is impossible to be certain of the number of preoral cirri; at least nine to a side are present.

Heteropleuron agassizii is related to H. bassanum, and especially to H. maldivense. In length it is between H. bassanum (43 mm.) and H. maldivense (22 mm.). The ratio of its depth to its length, one to nine, is almost exactly that of H. bassanum, and less than that of H. maldivense, one to six. The gonads, which in H. maldivense begin between the ninth and thirteenth myotomes and extend to a point between the thirty-third and thirty-ninth, in H. agassizii extend from the seventeenth to the forty-first. The caudal fin of H. agassizii, though much like that of H. maldivense, differs strikingly in its

simple outline from the more lancelike form of that of H. bassanum. Perhaps the best differential character lies in the ventral fin. In H. bassanum and H. maldivense the ventral fin has fin-ray chambers and fin-rays; in H. agassizii it has no chambers and no fin-rays. A summarized statement of the contrasts between H. agassizii and other allied species is given in Table 2, page 45.

Heteropleuron parvum, sp. nov.

Plate 2, Fig. 6.

Two specimens of this species were dredged in sixteen fathoms of water at Hanimadu, Tiladummati Atoll. They measured 11.5 mm. and 12.5 mm. in length respectively, and their depth is about one-tenth their length.

The dorsal fin is well developed, and is slightly higher posteriorly and especially anteriorly than in the middle. It has well marked fin-ray chambers extending from the anterior end of the nerve tube to the tail, and numbering about four to a myotome. In the middle region the chambers reach the free edge of the fin. Single fin-rays are present. Anteriorly the dorsal passes into the rostral fin, posteriorly into the inconspicuous caudal. The caudal fin, which is in no way marked off from the dorsal, is also continuous with the ventral, which contains a series of low fin-ray chambers and short single fin-rays. These are inconspicuous, and have not been shown in the figure (Plate 2, Fig. 6).

The myotome formula in both specimens is $40 + 18 + 10 = 68$.

The chorda is stout and almost reaches the anterior and posterior limits of the body.

The nerve tube contains a conspicuous anterior eye-spot, and from the third myotome to the last a series of smaller spots.

The gonads, which were completely present in only one specimen, formed a single series on the right side, and were sixteen in number. They extended from the fourteenth to the thirtieth myotome.

The structure of the ventral fin allies this species with the first four mentioned in Table 2. It differs from all these in its small size and narrow form, for it is even longer in proportion to its depth than H. bassanum, the narrowest of the four. From H. bassanum it differs markedly in its myotome formula, the small number of its gonads, and the simpler form of its tail.

A comparison of H. parvum and H. agassizii with other allied species is given in Table 2.

TABLE 2.

COMPARISON OF STRUCTURAL CHARACTERISTICS, ETC., OF HETEROPLEURON AGASSIZII, H. PARVUM, AND OTHER ALLIED SPECIES.

Name of Species.	Length in mm.	Ratio of Length to Depth.	No. of Gonads.	Myotome Formula.	Condition of Ventral Fin.
H. bassanum Günther . . .	43	9 : 1	26 to 31	45 + 16 + 14 = 75	Chambers with fin-rays.
H. hectori Benham	53	7 : 1	18 or more	53 + 19 + 12 = 84	" " "
H. maldivense Cooper . . .	22	6 : 1	23 to 30	45 + 16 + 12 = 73	" " "
H. cingalense Kirkaldy . .	27	8 : 1	20 to 26	39 + 16 + 8 = 63	" " "
H. parvum, sp. nov.	12	10 : 1	16	40 + 18 + 10 = 68	" " "
H. cultellum Peters	35	7 : 1	17 to 20	32 + 10 + 10 = 52	Chambers; no fin-rays.
H. agassizii, sp. nov. . . .	27	9 : 1	24	45 + 15 + 10 = 70	No chambers nor fin-rays.

Asymmetron orientale, sp. nov.

Plate 1, Fig. 4.

Seven specimens of this species were dredged in sixteen fathoms of water at Hanimadu, Tiladummati Atoll. They varied in length from 18 mm. to 9 mm., and their general proportions and structural features suggested at once that they belonged to the species Asymmetron lucayanum Andrews. Although the material on which Andrews based his description came from the Bahamas, Cooper (**1903**, p. 348) has recently claimed that the same form also occurs in the Maldives. In discussing this question he states that "the only point in which the Maldivan and West Indian forms consistently differ from one another is in their size. The average length of the Maldivan specimens is 23 mm., the extremes being 18 and 30 mm., thus being nearly double the length of the Bahama specimens which Andrews found to average 13 mm. In spite of this difference the average myotome formula for the two forms remains practically the same, the mode in each case being sixty-six myotomes, *i. e.* forty-four from the head to the atriopore, nine from the atriopore to the anus, and thirteen from the anus to the tail."

Observations on the seven specimens obtained by Mr. Agassiz confirm most of these statements, as may be seen by inspecting Table 3, in which records from three of the seven individuals are given, and below these for comparison average records for the eastern form as given by Cooper (**1903**, p. 348) and by Punnett (**1903**, p. 362), and for the western by Andrews (**1893**, p. 242). It is obvious, as Cooper states, that in all these characters, except size, the eastern individuals agree with the western ones.

TABLE 3.

Comparison of Eastern and Western Specimens of Asymmetron.

No. of Specimen.	Length in mm.	Sex.	Gonads.	Myotome Formula.
1	17.5	♂	28	44 + 10 + 12 = 66
2	18	♀	shed	46 + 10 + 13 = 69
3	9	♀	26	43 + 9 + 11 = 63
East form[1]	23		29	44 + 9 + 13 = 66
West form[2]	13		29	44 + 9 + 13 = 66

[1] Records for the eastern specimens as given by Cooper (**1903**, p. 348), and by Punnett (**1903**, p. 362).

[2] Records for the western specimens as given by Andrews (**1893**, p. 242).

The collection from the United States National Museum, which I had the privilege of studying, contained a few specimens of the West Indian Asymmetron donated by Dr. Andrews, and I therefore had the opportunity of making a close comparison between this and the eastern form. As a result of this comparison I found one structural feature in which the two sets of individuals consistently differed; this was the form of the caudal fin. In the West Indian specimens as figured by Andrews (**1893**, Plate 13, Figs. 1, 2), and as seen in the material before me (Plate **1**, Fig 3), the dorsal and particularly the ventral portions of the caudal fin in the vicinity of the myotomes were very broad, the fin becoming narrow and blade-like only on the urostyloid process. In the Maldivan forms (Plate **1**, Fig. 4) collected by Mr. Agassiz, the ventral portion of the caudal fin next the myotomes was only slightly broader than that under the urostyloid portion, and the dorsal portion next the myotomes was no broader than that over the urostyloid process. These features of the caudal fins in the two forms were so characteristically different in the material at my disposal that I do not hesitate to say that the seven Maldivan specimens certainly represent a species different from A. lucayanum, and I have therefore proposed the name of Asymmetron orientale for them.

While I am confident that the specimens collected by Mr. Agassiz are specifically distinct from A. lucayanum, I do not wish to be understood to imply that this species may not occur in the Maldives. Although the seven specimens examined by me have lengths not far from those of Cooper's specimens, they differ from the figure and description of these given by Cooper (**1903**, p. 348, Plate 18, Fig. 1) in the form of their caudal fins. The caudal fin, however, is an extremely delicate structure, and now that an important differential character has been found in it, a re-examination of its condition in Maldivan material heretofore supposed to be A. lucayanum would seem desirable before declaring this species to be an unquestionable member of the Maldive fauna.

Asymmetron macricaudatum, sp. nov.

Plate 2, Fig. 7.

Seven specimens of this species were in the collection of the Museum of Comparative Zoölogy. They were labelled "Salt Key Anchorage Fla." and were probably dredged on the Florida coast by the late Count Pourtalès. Two of the specimens were much curled and were of very little service for study; the remaining five were straight and in excellent preservation. The following description is based upon an examination of these.

The specimens varied in length from 14.0 mm. to 10.5 mm. and were over twelve times as long as they were deep (Plate **2**, Fig. 7).

The dorsal fin is low, particularly in its middle and anterior extent. From the second myotome to a region somewhat posterior to the anus there are low fin-ray chambers and short fin-rays. The fin-rays are generally block-like in

outline and occur one for each chamber. There are as a rule four fin-ray chambers to a myotome.

Anteriorly the dorsal fin passes over into a small rostral fin. Posteriorly it is continuous with the much reduced caudal fin which invests the long urostyloid process dorsally and ventrally as a very narrow blade. The caudal fin is continuous with the rather broad ventral fin, in which there are neither fin-ray chambers nor fin-rays.

The myotome formula may be given as 43 +5 + 14+ = 62+. Between the anterior end and the atriopore the number of myotomes varies from 42 to 44, and between the atriopore and the anus it is usually 5. For the region posterior to the anus an exact number cannot be given, for the reason that the most posterior myotomes are so small that it is impossible to count them or determine with certainty where the system terminates. In the enumerations for this region given in Table 4, only the numbers that could be counted with certainty are given, though in every case more myotomes were probably present. This is indicated by suffixing a plus sign to the numbers for this region and to the totals.

A well marked chorda passes through the animal almost from end to end, and forms posteriorly a delicate, long, urostyloid process.

The nerve tube has a distinct anterior eye-spot, and a series of numerous smaller spots extending from the third myotome to about the region of the anus.

The gonads, which vary in number from twenty-three to twenty-eight, form a single series on the right side. In a specimen with twenty-six gonads they extended from the eleventh to the thirty-seventh myotome.

A summarized statement of the chief structural features of the five specimens examined is given in Table 4.

TABLE 4.

STRUCTURAL CHARACTERISTICS, ETC. OF A. MACRICAUDATUM.

No. of Specimen.	Length in mm.	Sex.	No. of Gonads.	Myotome Formula.
1	13.5	♀	26	44 + 4 + 10+ = 58+
2	10.5	♀	26	42 + 5 + 17+ = 64+
3	14.0	♀	shed	42 + 5 + 19+ = 66+
4	12.5	♂	28	44 + 5 + 13+ = 62+
5	11.0	♂	23	43 + 5 + 11+ = 59+

The presence of gonads only on the right side of the body and the well developed urostyloid process place this species unquestionably in the genus Asymmetron. It differs from all known species of this genus in the form of its

caudal fin, which is narrower even than that in A. orientale, and in the small number of myotomes intervening between the atriopore and the anus. Table 5 gives in a condensed way some of the more obvious differences between this and the other known species of Asymmetron.

TABLE 5.

SPECIES OF ASYMMETRON CONTRASTED.

Name of Species.	Length in mm.	No. of Gonads.	Myotome Formula.
A. lucayanum Andrews	13	29	44 + 9 + 13 = 66
A. orientale, sp. nov.	23	29	44 + 9 + 13 = 66
A. caudatum Willey	20	30	44 + 9 + 11 = 64
A. macricaudatum, sp. nov. .	13	26	43 + 5 + 14+ = 62+

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EXPLANATION OF PLATES.

All the figures are camera drawings of specimens preserved and dehydrated in alcohol and cleared in clove oil.

PLATE 1.

Fig. 1. Right side of the anterior end of Branchiostoma pelagicum Günther. × 30.

Fig. 2. Right side of the posterior end of Branchiostoma pelagicum Günther. × 30.

Fig. 3. Left side of the posterior end of Asymmetron lucayanum Andrews, from the West Indies. × 40.

Fig. 4. Left side of the posterior end of Asymmetron orientale, sp. nov. × 25.

PLATE 2.

Fig. 5. Heteropleuron agassizii, sp. nov.; right side. × 5.

Fig. 6. Heteropleuron parvum, sp. nov.; right side. × 12.

Fig. 7. Asymmetron macricaudatum, sp. nov.; right side. × 10.

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows: —

E. EHLERS. The Annelids of the "Blake."
C. HARTLAUB. The Comatulæ of the "Blake," with 15 Plates.
H. LUDWIG. The Genus Pentacrinus.
A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
R. T. HILL. On the Geology of the Windward Islands.
W. McM. WOODWORTH. On the Bololo or Palolo of Fiji and Samoa.
AGASSIZ and WHITMAN. Pelagic Fishes. Part II., with 14 Plates.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows: —

A. AGASSIZ. The Pelagic Fauna.
" The Echini.
" The Panamic Deep-Sea Fauna.
K. BRANDT. The Sagittæ.
" The Thalassicolæ.
C. CHUN. The Siphonophores.
" The Eyes of Deep-Sea Crustacea.
W. H. DALL. The Mollusks.
H. J. HANSEN. The Cirripeds.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
C. A. KOFOID. Solenogaster.
R. VON LENDENFELD. The Phosphorescent Organs of Fishes.
H. LUDWIG. The Starfishes.
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JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
M. P. A. TRAUSTEDT. The Salpidæ and Doliolidæ.
H. B. WARD. The Sipunculids.
W. McM. WOODWORTH. The Nemerteans.
" The Annelids.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

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Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

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Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

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Contributions from the Geological Laboratory, in charge of Professor N. S. Shaler.

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25,345

Bulletin of the Museum of Comparative Zoölogy

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Vol. XLVI. No. 3.

BATRACHIA AND REPTILIA FROM THE BAHAMAS.

By Thomas Barbour.

CAMBRIDGE, MASS., U. S. A.:

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No. 3. — *Batrachia and Reptilia from the Bahamas.*

By Thomas Barbour.

This paper is the fourth of a series based on collections made by Dr. G. M. Allen, Mr. Owen Bryant, and the writer during part of the summer of 1904 (June 28–July 28). We collected on the islands of New Providence, Great Abaco, Little Abaco, Grand Bahama, as well as on a number of outlying cays. Some specimens from New Providence Island, taken by the author in 1901, and a large series collected by Mr. Bryant at Mangrove Cay, Andros Island, from August 1–7, 1904, are included. All the material mentioned is now in the Museum of Comparative Zoölogy, in Cambridge, Mass. A considerable number of other specimens, also in the collection of the Museum, have been utilized.

Cope has summed up the relations which the Bahaman reptilian fauna bears to the surrounding regions in a paper in the Proceedings of the United States National Museum, 1887, Vol. 10, pp. 436–439. Since then several peculiar species have been added by Garman, Bulletin Essex Institute, 1888, Vol. 20, pp. 101–113.

BATRACHIA.

Trachycephalus septentrionalis Tsch.

This tree-toad was abundant on New Providence Island, where we obtained fourteen specimens. Most of these were taken during the daytime, sitting among the leaves of orange and lemon trees, or on sisal plants. When approached, they made little or no effort to escape. Their noise at night sounds like that of a rope drawn through an unoiled pulley. The species was less common at Little Abaco, where only one specimen was obtained, though several others were heard. There is a specimen in the Museum from Andros Island, where Mr. Bryant heard several, but failed to obtain one. Garman has recorded the species from Rum Cay.

M. C. Z. No. 2415.

Distribution. — Bahamas, Cuba, Jamaica, and San Domingo.

Hyla squirella Bosc.

Two specimens of this species from the reeds of a brackish water marsh at Stranger Cay, north of Grand Bahama, are the first recorded from the Bahamas. Here they were common; and their chirp, as was pointed out at the time by Dr. Allen, who found them, was noticeably different from that of the other indigenous batrachians. As there are signs that this cay, though now uninhabited, has been cultivated in times past, it is possible that the species was introduced with imported plants. There were a number of the latter growing near the site of the single old house.

M. C. Z. No. 2419.

Distribution. — Southeastern North America generally.

Hylodes ricordii Dum. and Bibr.

We collected twenty-nine examples of this species from New Providence Island, where it was decidedly common under heaps of rubbish of almost any nature, but particularly decaying palm leaves. A single specimen from Marsh Harbor, Island of Abaco, differs considerably from the Nassau specimens in that the tip of the snout is pallid, and there are two distinct parallel white lines running down the back. This specimen possibly represents a local race, but additional material is needed to determine this question. A single example from Mangrove Cay, Andros Island, is very pale, and there is a noticeable interruption medially in the long series of vomerine teeth. I strongly suspect that another local race inhabits this island.

M. C. Z. No. 2416; 2417; 2418.

Distribution. — Cuba, Bahamas, and extreme southern Florida.

REPTILIA.

Sphaerodactylus flavicaudus, sp. nov.

Type series, fourteen specimens (M. C. Z. No. 6953) collected at Mangrove Cay, Andros Island, by Mr. Owen Bryant, August 1–7, 1904.

Specific characters. — Similar to *Sphaerodactylus decoratus* Garman in squamation, but differing widely in coloration and in proportions.

The general body color is that of pale cream, with the skin showing darker between the scales. Thus the entire surface appears to be covered with fine reticulations. On the tail this darker color shows itself in the form of rings. The tail, moreover, is bright orange-yellow. This species is more slender than *S. decoratus.* The head is unusually sharply pointed. In *S. decoratus*, particularly in the young, the length of the head and body considerably exceeds that of the tail. In *S. flavicaudus* the tail is almost always longer than the

head and body; in a few cases, however, these lengths were very nearly the same. The diameter of the tail at the base is less in the latter species than in the former.

The types were taken in chinks in the wall of the house in which Mr. Bryant stayed while at Mangrove Cay. He says that the species is very active and difficult to capture, except in the direct sunlight, when they appear to be somewhat dazed, and may be taken in the hand without difficulty.

Sphaerodactylus notatus Baird.

This lizard is not uncommon about Nassau in some of the limestone caves, where several were captured running about on the walls. There are before me thirteen specimens from New Providence, two from Stranger Cay, and one from Little Abaco Island.

M. C. Z. No. 6971; 6972; 6974.

Distribution. — Cuba, Bahamas, and vicinity of Key West, Florida.

Sphaerodactylus decoratus Garman.

In the collections made during the past summer there are thirty-two examples of this hitherto rare geckoid from Mangrove Cay, Andros Island, where Mr. Bryant found it very common about the houses, and also a single specimen from New Providence Island. These have been critically compared with the type, a single specimen from Rum Cay. There is also in the Museum of Comparative Zoölogy a single specimen from Andros Island, but the record is unpublished. So far as I can learn, the species has been heretofore unknown on New Providence.

M. C. Z. No. 6952; 6973.

Distribution. — Bahamas.

Anolis porcatus Gray.

This species was common on New Providence and Andros Islands; from the former locality eight specimens, and from the latter thirty-nine specimens were taken. We did not observe it at Abaco, whence it was recorded by Cope (Proc. U. S. Nat. Mus., Vol. 10, p. 437). A careful comparison of these specimens with others from Cuba shows a slight but apparently constant difference. In the Cuban specimens the longitudinal rugae of the head are rather more pronounced, and do not appear to involve so many scutes as in the Bahamam specimens. It is possible that this difference may warrant subspecific separation; but until a large series is available from various localities in Cuba, as well as in the Bahamas, a new name would only complicate this already over-perplexing genus.

M. C. Z. No. 6964; 6951.

Distribution. — Cuba, Bahamas, and Florida Keys.

Anolis distichus Cope.

Eighteen specimens of this species were taken on New Providence, and Mr. Owen Bryant obtained a fine series of fifty-four specimens from Mangrove Cay, Andros Island. It was very common on the big silk cotton-tree in Nassau, but is usually not so common as *A. sagrae*.

M. C. Z. No. 6950; 6956.

Distribution. — Bahamas, Haiti, and San Domingo.

Anolis sagrae Bibron.

This is the most widely distributed and abundant lizard in the Bahamas, and we obtained it at a number of scattered localities: five at Little Abaco, five at Grand Bahama, three at Moraine Cay, two at Pensacola Cay, five at Elbow Cay, ten at Stranger Cay, one at Marsh Harbor, Abaco, twenty at New Providence; and Mr. Bryant collected ninety-two at Mangrove Cay, Andros Island.

M. C. Z. No. 6959; 6960; 6957; 6963; 6977.

Distribution. — Bahamas, Cuba, Yucatan, Jamaica, east coast of Central America, and Venezuela.

Cyclura baeolopha Cope.

Mr. Bryant obtained a good series of this species on Andros Island. He states that the natives hunt them regularly for food, and that he had no difficulty in procuring specimens from them. He saw none himself about the village.

M. C. Z. No. 6975.

Distribution. — Andros Island replaced on Watling's, Turk's, and Cat Islands by *C. rileyi*, *C. carinata*, and *C. nubila*.

Liocephalus carinatus Gray.

We observed this species almost every day ashore during our cruise among the northern cays. Though recorded by Cope, it is unknown on New Providence Island, but it is said to occur on some of the small cays lying at some distance toward Eleuthera Island. Mr. Bryant states that it is unknown on "the mainland" of Andros, although not uncommon on certain of the outer cays. Specimens were taken at the following localities: Hopetown, Elbow Cay, three examples; Marsh Harbor, Abaco Island, two examples; Stranger Cay, one example; and Grand Bahama, one example.

M. C. Z. No. 6966; 6967; 6968.

Distribution. — Bahamas and Cuba.

Ameira thoracica Cope.

We collected fourteen specimens on New Providence Island and seven on Andros Island. I am unable to verify the occurrence of this species on the Island of Abaco, whence it was reported by Cope (Proc. U. S. Nat. Mus., Vol. 10, p. 438). Possibly the specimens were incorrectly labelled, and were from Andros Island. The species is said by Mr. Bryant to be rather common there, although I cannot find a previous record.

M. C. Z. No. 6948; 6965.

Distribution. — Bahamas.

Typhlops lumbricalis Linné.

A single specimen of this species was taken by the writer about ten miles northwest of Marsh Harbor, Abaco Island. It was found tightly curled up under a large rock in a sweet-potato field. When touched, it became very active, and it was only after considerable manoeuvring that it was caught.

M. C. Z. No. 6970.

Distribution. — West Indies and Guianas.

Epicrates strigilatus Cope.

A single specimen of this species was seen in the hands of an animal-dealer in Nassau. It was a rather large specimen, measuring, I should judge, six and one-half or seven feet. There is a specimen in the Museum from the same locality. Recorded also from Andros Island by Garman (Proc. Amer. Philos. Soc., 1887, p. 279).

M. C. Z. No. 6242.

Distribution. — New Providence and Andros Islands, replaced by *E. chrysogaster* on Turk's Island.

Ungualia pardalis Gundlach.

With a considerable series before me from New Providence Island, I disagree with Professor Cope in considering this species *U. maculata*. We took six specimens this summer; the writer obtained four previously, and there were two other specimens labelled *U. curta* by Garman, one from New Providence, the other from Cuba, in the Museum of Comparative Zoölogy. In all of these specimens part of the tail is black; in the smallest specimen only the extreme tip, in the largest specimen more than half. In some of these there are very many fine punctae on the gastrosteges, as well as the characteristic alternating spots. Two distinct color phases are evident; in three of the specimens the color is slaty-blue gray, the dorsal blotches being very distinct. In the others

the color is brownish or buff with the blotches rather inconspicuous. The squamation of these specimens exhibits a considerable range, and for this reason a table of the scale-counts is appended.

No. 6114. "*U. curta* Garman." Cuba.

Sc. $\frac{25}{153 + 30}$

No. 6491. "*U. curta* Garman." New Providence Island.

Sc. $\frac{25}{159 + 31}$

No. 6780. *U. pardalis* Gund. New Providence Island.

Sc. $\frac{25}{154 + 33}$

No. 6781. *U. pardalis* Gund. New Providence Island; three specimens.

a. Sc. $\frac{23}{150 + 31}$

b. Sc. $\frac{25}{152 + 32}$

c. Sc. $\frac{25}{154 + 34}$

No. 6969. *U. pardalis* Gund. New Providence Island; six specimens; collected in 1904.

a. Sc. $\frac{25}{158 + 34}$

b. Sc. $\frac{25}{159 + 28}$

c. Sc. $\frac{25}{156 + 33}$

d. Sc. $\frac{23}{156 + 37}$

e. Sc. $\frac{25}{158 + 32}$

f. Sc. $\frac{25}{157 + 33}$

Distribution. — Bahamas and Cuba.

Alsophis vudii Cope.

Two specimens of this snake were caught on New Providence Island; Mr. Bryant took one on Andros. A comparison of these with Cuban specimens of *Alsophis* (= *Dromicus*) *angulifer* shows that Dr. Boulenger is mistaken in con-

sidering the former synonymous with the latter. As is rather often the case in the preparation of his otherwise monumental catalogues, he has united in his synonymy several perfectly valid species, possibly because he personally has not verified the descriptions from actual specimens. From his list it appears that there were no specimens of this species from the Bahamas in the British Museum.

M. C. Z. No. 6954 ; 6955.

Distribution. — New Providence and Andros Islands, Bahamas.

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows: —

E. EHLERS. The Annelids of the "Blake."
C. HARTLAUB. The Comatulæ of the "Blake," with 15 Plates.
H. LUDWIG. The Genus Pentacrinus.
A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
R. T. HILL. On the Geology of the Windward Islands.
W. McM. WOODWORTH. On the Bololo or Palolo of Fiji and Samoa.
AGASSIZ and WHITMAN. Pelagic Fishes. Part II., with 14 Plates.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows: —

A. AGASSIZ. The Pelagic Fauna.
" The Panamic Deep-Sea Fauna.
K. BRANDT. The Sagittæ.
" The Thalassicolæ.
C. CHUN. The Siphonophores.
" The Eyes of Deep-Sea Crustacea.
W. H. DALL. The Mollusks.
H. J. HANSEN. The Cirripeds.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
C. A. KOFOID. Solenogaster.
R. VON LENDENFELD. The Phosphorescent Organs of Fishes.
H. LUDWIG. The Starfishes.
J. P. McMURRICH. The Actinarians.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
M. P. A. TRAUSTEDT. The Salpidæ and Doliolidæ.
H. B. WARD. The Sipunculids.
W. McM. WOODWORTH. The Nemerteans.
" The Annelids.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the Bulletin Vols. I. to XLI., and also Vols. XLIV. and XLV.; of the Memoirs, Vols. I. to XXIV., and also Vols. XXVIII., XXIX., and XXXI.

Vols. XLII., XLIII., XLVI., XLVII., and XLVIII. of the Bulletin, and Vols. XXV., XXVI., XXVII., XXX., XXXII., and XXXIII. of the Memoirs, are now in course of publication.

The Bulletin and Memoirs are devoted to the publication of original work by the Professors and Assistants of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation: —

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, in charge of Professor N. S. Shaler.

These publications are issued in numbers at irregular intervals; one volume of the Bulletin (8vo) and half a volume of the Memoirs (4to) usually appear annually. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Librarian of the Museum of Comparative Zoölogy, Cambridge, Mass.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. XLVI. No. 4.

THREE LETTERS FROM ALEXANDER AGASSIZ TO THE HON. GEORGE M. BOWERS, UNITED STATES FISH COMMISSIONER, ON THE CRUISE, IN THE EASTERN PACIFIC, OF THE U. S. FISH COMMISSION STEAMER "ALBATROSS," LIEUT.-COMMANDER L. M. GARRETT, U.S.N., COMMANDING.

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CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

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No. 4. — *Three Letters from* ALEXANDER AGASSIZ *to the* HON. GEORGE M. BOWERS, *United States Fish Commissioner, on the Cruise, in the Eastern Pacific, of the U. S. Fish Commission Steamer "Albatross,"* LIEUT. COMMANDER L. M. GARRETT, U. S. N., *Commanding.*

I.

LIMA, PERU, November 28, 1904.

THE "Albatross," under command of Lieutenant-Commander L. M. Garrett, left San Francisco on the 6th of October and arrived at Panama the 22d. On her way along the coast Professor C. A. Kofoid took advantage of the opportunity for making surface hauls with the tow nets as well as vertical hauls, generally to a depth of 300 fathoms. A large amount of pelagic material was thus collected, not at a great distance from the coast however. Off Mariato Point the "Albatross" made two hauls in the vicinity of the stations where in 1891 she found "modern green sand," in about 500 and 700 fathoms. It was interesting to find the green sand again, as the specimens collected in 1891 were lost in transit to Washington. I am fortunate in having as assistant for this trip, Professor Kofoid, who has had great experience in studying the Protozoa both in fresh water and at sea. He has been given charge of the collection of Radiolarians and Diatoms and of other minute pelagic organisms; and he will prepare a report on the results of that branch of the work of the expedition.

The "Albatross" arrived at Panama on the 22d; she was coaled and provisioned at once. On my arrival at Panama on the 1st of November I found her ready for sea, and on the 2d we left for Mariato Point to make a few additional trawl hauls in the region of the green sand. In both the hauls made off Mariato Point green sand was found, but not in the quantity obtained in 1891.

From Mariato Point we made a straight line of soundings towards Chatham Island in the Galapagos, intersecting the ring of soundings we made northeast of the islands in 1891. The deepest point of the line (1900 fathoms) was found about 100 miles southwest of Mariato

Point. The bottom continued to show about 1700 fathoms for nearly 200 miles, and then shoaled very gradually to 1418 fathoms about 80 miles from Chatham Island. The slope became quite steep, the 1000-fathom line not being more than 60 miles from Chatham Island. We ran a short line south of Hood Island, and found a somewhat steeper slope to that face of the Galapagos, reaching over 1700 fathoms in a distance of less than 50 miles, when the bottom remained comparatively flat, attaining a depth of 2000 fathoms about 100 miles farther south. This depth we carried eastward on a line to Aguja Point, until half-way the soundings had increased to over 2200 fathoms and remained at about that depth to within 60 miles of the coast, when the depth rapidly shoaled. From Aguja Point we ran a line of soundings to the southwest to a point about 675 miles west of Callao; on this line the depths gradually increased from 2200 fathoms, 100 miles off the Point, to nearly 2500 fathoms. On running east to Callao the depth soon increased to about 2600 fathoms, and at a distance of about 80 miles off Callao we dropped into the Milne-Edwards Deep and found a depth of over 3200 fathoms. We spent a couple of days in developing this deep, making soundings of 1490, 2845, 458, 1949, 2338, and 3120 fathoms; showing a great irregularity of the bottom within a comparatively limited area of less than sixty miles in diameter. Thus far all our soundings have been made with the Lucas sounding-machine.

In the Panamic basin to the northeast of the Galapagos we only trawled off Mariato Point, but we occupied ten stations with the tow nets, hauling both at the surface and at 300 fathoms, and vertically from that depth; we also continued this pelagic work at nearly all the stations (35) from the Galapagos to Callao.

When off Chatham Island we began to trawl and used the tow nets regularly, occupying twenty stations. The nets were in charge of Mr. F. M. Chamberlain. The pelagic collections, as a whole, are remarkably rich. They are especially noteworthy for the great variety and number of pelagic fishes obtained inside the 300-fathom line at a considerable distance from shore, — from 300 to 650 miles. Many of these fishes had been considered as true deep-sea fishes to be obtained only in the trawl when dredging between 1000 and 1500 fathoms or more. On one occasion the tow net brought up from 300 fathoms, the depth being 1752 fathoms, no less than 12 species of fishes; of one species of Myctophum we obtained 18 specimens; of another, 37; of a third, 45; in all, nearly 150 specimens. On other occasions it was not uncommon to obtain 8 or 10 species, and from 50 to 100 specimens. Among the

most interesting types obtained in the tow net I may mention as coming from less than 300 fathoms, Stylophthalmus and Dissoma, both of which Chun considers as deep-sea fishes, found from 600 to 4000 metres; also a species of Eurypharynx obtained for the first time in the Pacific. Stylophthalmus I had also caught in a tow net in 1900, during the tropical Pacific Expedition of the "Albatross," in depths of less than 300 fathoms. In the lines we ran across the great northerly current which sweeps along the coast of Peru and Chili and is deflected westward at the easterly corner of the Galapagos Islands, we obtained with the tow nets an unusually rich pelagic fauna at depths less than 300 fathoms. We collected a number of Schizopods, among them many beautifully colored Gnathophausiae, pelagic Macrurans; huge, brilliant red Copepods, as well as many other species of blue, gray, mottled, and banded Copepods. Lucifer and Sergestes were abundant in many of our hauls. Many species of Amphipods were collected, Hyperids without number, especially where the surface hauls were made among masses of Salpae, which, on several occasions, formed a jelly of Tunicates. Several species of Phronimae also occurred constantly in the tow nets. Sagittae were very numerous, a large orange species being noteworthy. Several species of Tomopteris, some of large size and brilliantly colored, violet or carmine with yellow flappers, and two species of Pelagonemerteans. Two species of orange-colored Ostracods were also common, one having a carapace with a long spiny appendage. We obtained several species of pelagic Cephalopods, Cranchia and Taonis among them. Two species of Doliolum also occurred, but they were never as abundant as the Salpae, two species of which often constituted the whole contents of the tow net.

In the surface and deeper tows we also procured a number of Acalephs; we have thus far collected more than 50 species of Medusae and Siphonophores, many of which have been figured by Mr. Bigelow, differing from those of the 1891 Expedition. Atollae, and other deep-sea Medusae, were common within the 300-fathom line. The Salpae guts gave us, in addition to the finer tow nets, immense collections of Radiolarians, Diatoms, Dinoflagellata, many of which have been considered to live at great depth and upon the bottom. The number of Diatoms found in this tropical region is most interesting. They have usually been considered as characteristic of more temperate and colder regions. On several occasions the surface waters were greatly discolored by their presence, and the extent of their influence on the bottom deposits is shown by the discovery of a number of localities where the

bottom samples at depths from 1490 to 2845 fathoms in the track of the great Peruvian current formed a true infusorial earth.

The tow nets also contained many species of Hyalea, Cymbulia, Styliola, Cleodora, Tiedemannia, Clio, and the like. On one occasion the mass of the pelagic hauls consisted entirely of small brown Copepods, the contents of the tow nets looking like sago soup. Another time Sagittae, Salpae, Doliolum and Liriope, all most transparent forms, formed the bulk of the tow net's catch. Again, Firoloides and Carinarias constituted the bulk of the haul. These catches, coming on successive days or interrupted with hauls of more than mediocre quality, show how hopeless it is at sea to make any quantitative analysis of the pelagic fauna and flora at any one station within the influence of such a great oceanic current as the Chilian and Peruvian stream.

Hauls of the trawl made at the western extremity of our lines brought us within the area of the manganese nodules, with its radiolarian ooze mud, shark's teeth, Cetacean ear-bones and beaks of Cephalopods; nothing could stand the damaging work of these nodules in grinding to pieces all the animal life the trawl may have obtained. Down to the depth of 2200 fathoms or so the bottom was covered by Globigerina ooze, its character being more or less hidden when near the coast by the amount of detrital matter and terrigenous deposits which have drifted out to sea.

North of the Galapagos we found vegetable matter at nearly all the stations, and between the Galapagos and Callao such material was not uncommon in the trawl.

Beyond the line of 2200 fathoms dead Radiolarians became quite abundant on the bottom, as well as in the mud of the manganese nodules, though among the nodules it was not uncommon to find an occasional Biloculina. Many of the dead Radiolarians found on the bottom Professor Kofoid found in the guts of Salpae swimming near the surface or within the 300-fathom line in the tow nets sent to that depth. The same is the case with many of the Dinoflagellata which had been considered as deep-sea types. In our tow nets from 300 fathoms we found very commonly Tuscarora, Tuscarosa, Aulospira, and others. In depths of 300 fathoms to the surface the tow net was rich in Tintinnidae, either dead or moribund Planktoniellae, and Dinoflagellata. Among the Dinoflagellata there were 10 species of Ceratium, 9 of Peridinidae, Gonyaulax, Phalacroma, Pyrocystis, Cyttarocylis, Undella, and Dictiocystus. On the surface Planktoniella sol predominates with Asteromphale, Biddulphia, and Synidia thalassothrix; among the Dinoflagellata we obtained 12 species of Ceratium, 5 of Peridinium, and 22 species of other Peredinidae.

Among the Tintinnidae were a number of Sticholonche; among the Acantheriae were specially to be noticed Acanthometra, Acanthostaurus, Amphilonche, Collozoum, Thalassicola, and a number of Chirospira murrayana, and a few Challengeridae.

Our trawls brought up from the bottom many interesting fishes, among which I may mention Bathypterois, Ipnops, a few bat fishes, all species thus far described by Mr. Garman from the 1891 Expedition. I may also mention a Chimaera, different from the Chili species. The fish have been admirably cared for by Dr. J. C. Thompson, U.S.N. Among the Crustacea: Lithodes, Munidopsis, and many Macrurans, all well-known species of the 1891 Expedition. We found a few Mollusks, and a few interesting genera of tubicolous Annelids. Compared to the 1891 Expedition, few starfishes and brittle stars were obtained, and still fewer sea urchins, only one species of Aceste and one of Aërope, a marked contrast to the numerous Echini collected in the Panamic basin in 1891. We obtained, however, a magnificent collection of Holothurians; nearly every species occurring in the Panamic basin being found in numbers in our track south of the Galapagos, in the wake of the great Chilean-Peruvian current and at considerable depths. On one occasion, at Station 4647, in 2005 fathoms, we obtained no less than 16 species of Holothurians, among them brilliantly colored Benthodytes, Psychropotes, Scotoplanes, Euphronides, and the like. At Station 4670, in 3209 fathoms, we obtained 6 species of Holothurians. At Station 4672, in 2845 fathoms we also obtained very many specimens of three species of Ankyroderma, a large Deima, 2 species of Scotoplanes, 2 of Psychropotes, with a number of young stages of that genus; repeating thus the experience of the "Challenger," which found Holothurians in abundance at great depth, not only in the number of specimens, but also of species, though the "Challenger" did not at any locality obtain as many as we did at Station 4647. Mr. Westergren made a number of colored sketches of the species which were not obtained in the 1891 Expedition. We also collected in the trawl a number of deep-sea Actinians, none different, however, from genera found previously in the Panamic district. We also obtained a few Pennatulids, Gorgonians, and Antipathes, and a very considerable number of siliceous Sponges, usually associated with the Holothurians found in deep water in the track of the Peruvian current. In the track of the current at not too great distances from the coast we invariably brought, even from very considerable depths, sticks and twigs and fragments of vegetable matter. On two occasions we brought up in the trawl specimens of Octacnemus. The

trawl had been working at 2235 and at 2222 fathoms. Both Moseley and Herdman described this interesting Ascidian as attached to the bottom by a small peduncle. While the presence of the peduncle cannot be denied, yet its attachment, if attached at all, must be of the slightest. Its transparent slightly translucent body, with its eight large lobes, suggesting rather a pelagic type than a sedentary form. This Ascidian was discovered by the "Challenger" west of Valparaiso.[1]

Mr. Chamberlain made two daily observations of the density of the water, and found the same discrepancies between our observations and those of 1891 with those given by the "Challenger" and in the Deutsche Seewarte Atlas of the Pacific Ocean. Whenever we took a serial temperature, he also determined the density at 800 fathoms. We occupied six stations for the serial temperatures, two on the western termini of the lines normal to the coast across the great Peruvian current, two in the centre of the current, and two at a moderate distance from the coast. These serials developed an unusually rapid drop in the temperature between the surface and 50 fathoms, nearly 12°, at the western extremity of the northern line, the temperature having dropped from 71.7° at the surface to 59.2°. At 200 fathoms it was 51°, and at 600 fathoms it had dropped to 40.7°, the bottom temperature at 2005 fathoms being 36.4°. The temperature of the station in the central part of the current in 2235 fathoms agreed with the western series. At the eastern part of the line in 2222 fathoms, with a bottom temperature of 36.4°, the surface being only 67°, we found again a close agreement at 50 and 100 fathoms, the lower depths at 400 and 600 fathoms being from one to two degrees warmer than the outer temperatures. On taking a serial from the surface to 100 fathoms, we found that the greatest drop in temperature took place between 5 and 30 fathoms.

The temperatures of a line running due west from Callao showed a very close agreement both at the western end of the line about 780 miles from the coast and in the central part of the line, as well as in the shore station about 80 miles from the coast in 3209 fathoms. The bottom temperature in nearly all the depths we sounded was 36°, a high temperature for that depth. I do not make at present any comparison with the serials taken in the Panamic district in 1891 until we shall have completed our lines to the south and to the west.

We leave for Easter Island on the 3d of December, where we shall

[1] In the Albatross Tropical Pacific Expedition (1899–1900) Octacnemus was obtained in the tow net from less than 150 fathoms at Station 15, Lat. 4° 35′ N., Long. 136° 51′ W.

coal, and go from there to the Galapagos and thence to Manga Reva and Acapulco, where we ought to arrive in the early days of March.

The changes made in the working apparatus of the "Albatross" under the superintendence of Lieutenant Franklin Swift, U. S. N., have proved most satisfactory. The changes made in the main drum and the device for preventing the piling of the wire on the surging drum and the accompanying shock have greatly reduced the risk of breaking the wire rope when trawling at great depths. The wire rope has proved an excellent piece of workmanship, and has worked admirably in the comparatively deep water in which most of our trawling has been done thus far. A new dredging-boom has also been installed, and everything relating to the equipment of the "Albatross" has been carefully overhauled.

Lieutenant-Commander L. M. Garrett has been indefatigable in his interests for the expedition, the officers and crew have been devoted to their work, and the members of the scientific staff have carried out most faithfully their duties of preparing and preserving the collections thus far made.

We hoped to be docked at Callao, but owing to the prolonged occupation of the dock by a disabled steamer, and the uncertainty of its becoming free within reasonable time, we decided to proceed without further delay to Easter Island and continue the expedition as we are.

II.

Chatham Island, Galapagos, January 6, 1905.

We left Callao for Easter Island Saturday afternoon, December 3; as far as 90° western longitude we remained in the Humboldt current, as we could readily see from the character of the temperature serials and from the amount of pelagic life we obtained both from the surface and the intermediate hauls. This also affected the bottom fauna, which was fairly rich even as far as 800 miles from the shore as long as we remained within the limits of the northern current. As soon as we ran outside of it the character of the surface fauna changed; it became less and less abundant as we made our way to Easter Island, the western half of the line from Callao to Easter Island becoming gradually barren. This also affected the deep-sea fauna to such an extent that towards Easter Island, at a distance of 1200 to 1400 miles from the South American continent, our trawl hauls were absolutely barren; the bottom for the greater part

of the line being covered with manganese nodules on which were found attached a few insignificant siliceous Sponges, an occasional Ophiuran, and a few Brachiopods or diminutive worm tubes; the same bottom continuing to Sala y Gomez and between it and Easter Island. Sala y Gomez and Easter Island are connected by a ridge on which we found 1142 fathoms near Sala y Gomez, and 1696 fathoms between it and Easter Island. The ridge rises rapidly from about 2000 fathoms, the general oceanic depth within about 100 miles, to over 1100 fathoms within a comparatively short distance from both Sala y Gomez and Easter Island.

The southern part of our line from Easter Island to the Galapagos shows all the characteristic features of the western part of the line from Callao to Easter Island: like it, as far as the 12th degree of southern latitude, it proved comparatively barren, the bottom consisting of manganese nodules to within about 250 miles of the Galapagos. The pelagic and intermediate fauna from Easter Island to 12° south latitude was very poor, and the serial temperatures show that we were outside and to the westward of the great Humboldt current. But near the 12th degree of southern latitude a sudden change took place; the pelagic and intermediate fauna became quite abundant again, and soon fully as rich as at any time in the Humboldt current. There was also a marked change in the temperature of the water as shown by the serials; showing that from the 12th degree of southern latitude to the Galapagos we were cutting across the western part of the Humboldt current. The great changes of temperature which took place in the layers of the water between 50 and 300 fathoms are most striking, and show what a disturbing element the great mass of cold water flowing north must be in the equatorial regions of the Panamic district to the south and to the north of the Galapagos. South of the Galapagos the western flow of the Humboldt current must be nearly 900 miles wide and of about the same width when running parallel to the South American coast.

The range of temperatures between 30 and 150 fathoms is at some points as great as 21°. Such extremes cannot fail to affect the distribution of the pelagic fauna, and may account for the mass of dead material often collected in the intermediate tows when hauling at depths of less than 300 fathoms, when the range becomes as great as 28°. Such a range of temperature is far greater than that of the isochrymic lines which separate coast faunal divisions. The bottom fauna, as we entered the Humboldt current going north, gradually became richer in spite of its being covered with manganese nodules.

The two lines centring at Easter Island developed the "Albatross" plateau indicated on the "Challenger" bathymetrical charts, on the strength of a few soundings reaching from Callao in a northwesterly direction, and of a couple of soundings on the 20th degree of latitude. The Albatross plateau is marked as a broad ridge separating the Buchan Basin from the deep basin to the westward, of which Grey Deep and the Moser Basin are the most noted areas.

Our line from Easter Island to the Galapagos showed a wonderfully level ridge, varying in depth only from 2020 to 2265 fathoms in a distance of nearly 2000 miles. The soundings we made to the eastward from the Galapagos to the South American coast, and to the westward of Callao, as well as on the line from Callao to Easter Island, all indicate a gradual deepening to the eastward to form what the "Challenger" has called the Buchan Basin with a greatest depth of 2400 to over 2700 fathoms, and passing at several points near the coast to Milne, Edwards, Krümmell, Richards and Haeckel Deeps, some of them with a depth of over 4000 fathoms. According to the "Challenger" soundings, the Juan Fernandez plateau connects with the Albatross plateau, and forms the southern limit separating Buchan Basin from the Barker Basin to the south of the Juan Fernandez plateau.

At Easter Island we found our collier awaiting our arrival. We moved from Cook Bay to La Pérouse Bay to coal, as there was less swell there than in Cook Bay, where we could scarcely have gone alongside to take in coal.

Considerable shore collecting was done at Easter Island. We must have brought together at least 30 species of plants. The flora of Easter Island is very poor. There are no trees nor native bushes — not even the bushes which characterize the shore tracts of the most isolated coral reefs of the Pacific are found there; and yet some of the equatorial counter currents must occasionally bring flotsam to its shores. We collected a number of shore fishes and made a small collection of the littoral fauna. The fishes have a decided Pacific look, and the few species of sea urchins we came across are species having a wide distribution in the Pacific.

While coaling, we spent some time examining the prehistoric monuments which line the shores of Easter Island. During our stay at La Pérouse Bay we visited the platforms studding the coast of the bay, and made an excursion to the crater of Rana Roroka, where are situated the great quarries from which were cut the colossal images now scattered all over the island, many of which have fallen near the platforms upon which

they were erected. Near Rana Roroka, at Tongariki, is the largest platform on the island, about 450 feet in length, to the rear of which are fifteen huge images which have fallen from the pedestals upon which they once stood. The plain in the rear of the platform is crowded by stone houses, most of which are in ruins.

On our return to our anchorage at Cook Bay, we examined the platforms within easy reach of the settlement, and also the crater of Rana Koa, on the north rim of which, at Orongo, are a number of the stone houses built by the people who quarried the great stone images. At Orongo are also found sculptured rocks, but neither the sculptures nor the images show any artistic qualities, though the fitting of some of the cyclopean stones used in building the faces of the platforms indicate excellent and careful workmanship. To Mr. C. Cooper, manager of the Easter Island Company, we are indebted for assistance while visiting the points of interest of the island. He was indefatigable in his exertions in our behalf.

We took a number of photographs during our stay, illustrating not only the prehistoric remains, but giving also an idea of the desolate aspect of Easter Island during the dry season.

We arrived at Wreck Bay, Chatham Island, Galapagos, on the third of January, where we found a schooner with a supply of coal. As soon as the ship has been overhauled and coaled we shall start for Manga Reva, where we ought to arrive the last days of January. We reached Chatham Island towards the end of the dry season. Everything is dried up, the vegetation seems dead with the exception of a few small wild cotton plants, weeds, cactus, and an occasional Mimosa; and the great barren slopes present fully as uninviting an aspect as when Darwin described them. When the "Albatross" visited the Galapagos in March, 1891, everything was green, presenting a very marked contrast to its present desolate appearance.

III.

ACAPULCO, MEXICO, March 26, 1905.

We left the Galapagos (Wreck Bay) for Manga Reva the 10th of January.

On the northern part of this line we did but little work beyond sounding, as we were likely to duplicate our former work to the eastward. The fourth day out, in latitude 5° S., we began a series of trawl hauls, surface and towing to 300 fathoms. In the northern part

of the line to Manga Reva the hauls were remarkably rich as long as we remained within the influence of the western extension of the Humboldt current, and as long as there poured from the surface masses of the Radiolarians, Diatoms, and Globigerinae living at or near the surface. Some of the hauls were remarkable for the number of deep-sea Holothurians and siliceous Sponges. Among the former I may mention a huge Psychropotes, 55 c. m. long.

As we passed south and gradually drew out of the influence of the western current, we entered the same barren region we passed through to the eastward when going to and from Easter Island. By the time we reached latitude 15° S., the hauls became quite poor, and this barren bottom district extended to within a short distance of Manga Reva; corresponding to it near the surface we found a most meagre pelagic fauna, both at the surface and down to 300 fathoms — so poor that it could afford but little food to the few species, if any, living on the bottom in that region.

We arrived at Manga Reva on the 27th of January and found our collier awaiting our arrival.

While at anchor in Port Rikitea, we examined Manga Reva, the principal island of the Gambier group, from its central ridge on the pass leading from Rikitea to Kirimiro on the west side of Manga Reva, as well as from the pass leading to Taku. On both these passes we obtained excellent views of the "barrier reef" to the west, north, and east of the Gambier Islands, and we could trace in the panorama before us the western reef extending in a northeasterly direction parallel to the general trend of Manga Reva Island for a distance of about 5½ miles.

From the northern horn to nearly opposite Kirimiro Bay the barrier reef has only three small islets. It is narrow, of uniform width (about ⅓ of a mile), plainly defined, submerged in places, and passing north bounds a large northern bight dotted with numerous interior coral patches from a quarter of a mile to a mile in diameter or length, with from 7 to 11 fathoms. The southern part of the western barrier lagoon off Manga Reva is irregularly dotted with many small patches of reef, with an occasional deep hole near Manga Reva Island of from 15 to 20 fathoms. From the islet to the west of Kirimiro there are but few coral patches, indicating a reef which dips gradually in a distance of a mile to a deeper channel of from 4 to 6 fathoms, which separates the northern and western reef from the great reef flat lying to the southwest of Tara Vai. This flat has a width of nearly 2 miles, it is about 4½ miles long, and is marked at its southwest extremity by a series of

low islets arranged in a somewhat circular line, formed by 3 deep bays and spurs from the outer line of islets, as so frequently occurs on wide reef flats in atolls of the Pacific.

This part of the reef is called Tokorua. This reef flat shelves very gradually from $3\frac{1}{2}$ to 4 fathoms on the west face to 7, and connects with the "plateau" upon which stand Tara Vai and Aga-kanitai. From Tokorua the reef extends in an indefinite narrow ridge 8 miles long, with from 3 to 8 fathoms, in a southeasterly direction. The western edge is steep to, and the eastern face passes gradually into the lagoon, which at that point has a general depth of 8 to 20 fathoms; the deepest part of this region being at the foot of Mt. Mokoto between it and Tara Vai, though Tara Vai is united with Manga Reva Island by a plateau varying in depth from $3\frac{1}{2}$ to $4\frac{1}{2}$ fathoms.

At the southeastern point of the reef it passes into a wide plateau with from 9 to 10 or 15 fathoms. The plateau is about 9 miles wide southwest of Tekava. That part of the atoll has not been well surveyed, so that the position of the reef flat has not been ascertained further west on that part of the east face; but the southeast passage indicates $5\frac{1}{2}$, 6, and $6\frac{1}{2}$ fathoms where it probably marks the southwestern extension of the eastern barrier reef, separating the lagoon from the southern plateau to the south of the encircling reef.

The western faces of Manga Reva and of Tara Vai are indented by deep bays, formed by spurs running from the central ridge of these islands, the remnants probably of small craters which flanked the large crater, of which Manga Reva forms the western rim and Au Kena is the remnant of the southeastern edge, the former extension of this rim being indicated by the spits uniting the base of Mt. Duff with Au Kena, and by the projection of Au Kena towards the outer barrier reef, and by the numerous patches of coral reef off the northeast point of Manga Reva towards the outer line of Motus till they almost unite with the barrier reef.

The whole of the western bays of Manga Reva Island are filled by fringing reefs which leave but here and there a deeper pass to the shore. The south face at the foot of the bluff of Mt. Mokoto and Mt. Duff is edged by a flourishing, fringing reef extending nearly half a mile on the plateau at their base. The port of Rikitea is a reef harbor formed within the large fringing reef which occupies the whole of the southern bay of Manga Reva Island. The east face of Tara Vai and part of the east and of the west face of Aga-kanitai are also fringed by reefs.

The islets and islands of Aka Maru, Mekiro, and Maka-pu are within

a fringing reef flat which runs around the west face of Aka Maru; Au Kena is also edged by an extensive fringing reef which runs out in a spit of more than half a mile, in a northeasterly direction almost to the outer line of Motus, which are nearly united with it by irregular patches. To the west of Au Kena a huge spit of 2 miles in length extends towards the base of Mt. Duff and almost unites with the fringing reef off the Cemetery, leaving a narrow but deep pass for the entrance of ships into the inner harbor of Rikitea. There is only from 1 to $2\frac{3}{4}$ fathoms of water on these two spits.

The depth of the basin within this area with from 25 to 31 fathoms would be naturally explained as being part of an ancient crater, as in Totoya in Fiji; its northeastern rim is also perhaps further indicated by the comparatively shallow flat of the lagoon to the west of the barrier reef, with from 5 to 11 fathoms of water.

The principal islands of the group are in the central part of the lagoon. The four larger islands are Manga Reva, Tara Vai, Au Kena, and Aka Maru. Tara Vai is flanked by Aga-kanitai and another islet to the west called Topunui; Aka Maru is flanked by Mekiro to the north, and by Maka-pu to the south. The southeast face of Aka Maru is an extinct crater, of which Maka-pu forms the south rim. The main ridge of Tara Vai is the edge of parts of three craters now opening to the west. The four small volcanic islands in the southern part of the lagoon are isolated fragments, steep to, greatly weathered, and disintegrated. No soundings exist to show their relation to the other islands of the group.

The soundings thus far made indicate in the southern part of the lagoon a depth of about 23 fathoms, with an occasional hole of from 38 to 40, and a gradual slope towards the outer sunken reef. To the south of the old crater of Manga Reva the general depth of the banks varies from 6 to 11 fathoms, with a deeper channel varying from 20 to 40 from southwest of Au Kena towards Tara Vai. The lagoon seems to form a western basin where the depth varies from 10 to 20 fathoms. To the west of Au Kena and Aka Maru, lying between them and the line of the outer barrier reef islets. A similar but shallower basin exists, off the northern end of Manga Reva, between it and the northern horn of the barrier reef, with from 7 to 11 fathoms. Its rim is formed by a ring of reef patches of very varying size.

On two occasions we visited the outer barrier reef and examined the outer line of islets of the eastern face of the Gambier Islands. The position of the islets as marked on the chart is not that of to-day, and the position of the reef flats is not correct. The position of Tekava and Tauna appears

to be correct. Opposite Au Kena and in its extension the east face of the barrier reef projects sharply to the east, forming an angular horn, with one island south of the horn and the other north running at a sharp angle with it, so as to form a triangle which makes a deep bight opening westward to such an extent that when off the northern side of the horn we could see Tekava far to the westward of it. The second island is followed by a third, and then by a long island — Tarauru-roa — nearly 2 miles long; these are separated by small gaps. Then comes a larger island — Amou — followed by three small islands separated by deep gaps.

At Vaiatekeue (not the Vaiatekeua on the chart), the reef flat becomes quite narrow, it is hardly more than 100 yards wide, the islets perhaps 50. The northern islets are small and separated by long stretches of low shingle, and carry but little vegetation and very few cocoanut trees. There are but two short sand beaches all the way from the northeastern to the eastern horn of the eastern face of the encircling reef of Manga Reva. A regular dam of shingle from 10 to 14 feet high, on the top of which the usual coral reef vegetation flourishes, extends along the outer face of the reef flat, which varies from 50 to 150 yards in width, and is flanked at the base by low buttresses of modern elevated coral reef rock and of breccia in places all more or less weather-beaten and honeycombed.

The islets, and their formation, and their junction or separation into larger or smaller islets, and the gaps which separate them, the mode of formation of the buttresses, of the planed-off, hard, nearly level reef flat, of the coralline mounds of the outer edge, — all these differ in no way from what has been described in other barrier reef islands and atolls of the Pacific.

The beaches of the lagoon are steep, and corals do not seem to thrive in those parts of the lagoon to which the sea does not have access or at some distance from shore. This is well shown by the vigorous growth of corals in the fringing reef to the south of Mt. Duff on the outer edges of the reef patches of Port Rikitea, and on the spits which connect Au Kena with Manga Reva, contrasted to those along the west face of the lagoon flats to the west of the eastern barrier reef.

There is a northeast horn of the eastern barrier reef in the extension of Manga Reva Island, forming the northern culmination of the central bight of the eastern face of the barrier reef. From that point the reef flat runs westerly to form the northern horn about 3 miles north of Manga Reva Island. The position of the outer reef cannot be correct

on the chart (H.O.2024). On leaving Manga Reva, we made three soundings close off the reef flat line of breakers, — one off Tekava, at the most one-third of a mile from the reef, in 225 fathoms. Our position plotted by tangents to the volcanic islands or by their summits indicated in this case, on the chart, a distance of 1½ miles. A second sounding of 245 fathoms off the eastern horn at less than one-half mile, indicated on H.O. chart 2024 a distance of 2 miles from the horn; and a sounding of 241 fathoms one-fourth of a mile off the point which we had visited (Vaiatekeue) indicated a distance of three-fourths of a mile on the chart.

The slope of the Gambier archipelago to the east is steep. On coming in sight of Manga Reva we sounded in 2070 fathoms at a distance of 11 miles from Mt. Duff, that is, 6 miles from the outer edge of the reef bearing southwest; and on coming out we sounded again half-way to that point at a distance of 3¼ miles from the breakers in 1394 fathoms.

One cannot fail to be struck with the similarity of the Manga Reva archipelago to the great atoll of Truk. If I remember rightly, Darwin also called attention to this from a study of the charts. Yet, owing to the great size of Truk, no less than 125 miles in circumference, and the great distance of the barrier reef from the encircled volcanic islands, the effect as one steams into Manga Reva is totally different from that produced by Truk. In the latter some of the islands, though large, and of the same height as those of Manga Reva, are much more scattered, and seem of comparatively small importance in the midst of the huge lagoon which surrounds them. The barrier reef islets of Truk are from 11 to 15 miles distant from the encircled volcanic islands. In Manga Reva, which is only 45 miles in circumference, after passing the small islands in the southern and open part of the lagoon when once off Maka-pu, we can fairly well take in the atoll as a whole. The western island (Tara Vai) is only 5 miles off; Manga Reva and Au Kena are about 3, as are also the islets of the east face of the barrier reef. These distances, as you approach the entrance to Rikitea, are constantly growing less, so that when in the gap between Manga Reva Island and Au Kena, at the foot of Mt. Duff, none of the larger islands are more than 3 miles off; and the islets of the eastern face of the barrier reef are seen to the northeast about 4 miles off. When on the summit of the central ridge of Manga Reva, one can, in a radius of a little more than 4 miles, take in the whole panorama of Manga Reva, and get an impression of the relations of its different parts far better than it can be conveyed by

the chart, for the whole of the visible part of the archipelago is included in a line drawn east and west, south of Maka-pu; south of that line the position of the southwestern reef can be traced only by the discoloration of the water.

Manga Reva is an intermediate stage of erosion and denudation between an archipelago lagoon such as Truk and a barrier reef island like Vanikoro, and other islands in the Society group, as Bora Bora,[1] Huaheine, Raiatea, Eimeo, in which the surrounding platform has comparatively little width and the barrier reef is close to the principal island and often becomes a part of its fringing reef. Manga Reva is open to the south and to the west, Vanikoro to the east, while the volcanic islands of Truk are completely surrounded by the outer encircling barrier reef, as are the Society Islands just mentioned, which have several wide passages into the lagoon through the wide barrier reef.

One is tempted to reconstruct the Gambier Archipelago of former times, and to imagine it with a great central volcano, with a deep crater of more than 34 fathoms, of which Manga Reva and Au Kena are parts of the rim which once were connected from the southeast point of Manga Reva to Au Kena, and thence along the line of the outer islets to the northeast end of the former island. On the west face it was flanked by smaller craters extending to the western islets of the barrier reef of which the bays of Taku, Kirimiro, and Rumaru, and the bays of the west side of Tara Vai are the eastern ridges. There were probably also other secondary volcanoes, of which Aka Maru and the islets of the south part of the lagoon are the remnants, the latter all being situated on the gentle slope of the southern part of the Manga Reva plateau; this may have been the southern slope of the principal volcano of the group on the face of which have grown up the outer line of the barrier reef and its islets.

The existence of a central volcano with a deep crater would readily explain the great depths of the lagoon in its different regions, and off the outer face of Manga Reva, depths showing slopes which are no steeper nor more striking than the heights and slopes of the southern part of Manga Reva, of Tara Vai, of Aka Maru, and of Maka-pu; supposing them to be extended into the sea.

Mt. Mokoto and Mt. Duff drop precipitously for more than one-third their height, and in less than a quarter of a mile fall from over 1300 feet to the level of the sea. Similar slopes are found along the volcanoes

[1] See A. Agassiz. The Coral Reefs of the Tropical Pacific, Plates 210 and 231.

of Easter Island where there are no coral reefs. The edge of the crater of Rana Kao drops perpendicularly a height of nearly 1000 feet in less than one-eighth of a mile horizontal distance; and the eastern face of the crater of Rana Roroka rises vertically about 800 feet above the plain of Tangariki.

It is interesting to note how poor is the flora of the Manga Reva archipelago as compared with that of the more western volcanic islands like the Marquesas and the Society Islands and some of the western elevated Paumotus. In the Gambier Archipelago the forests are reduced to a few patches extending along the small valleys of the slopes of the volcanic spurs. I am informed that even in the thirties of the last century, when the missionaries first landed at Manga Reva, the forest trees while more numerous yet never attained the luxuriance of growth that they attain in the Society and Marquesas Islands. At the present day, with the exception of the forest patches just mentioned and a few trees which have been introduced for cultivation, the islands of the group are in great part thickly covered with a species of cane closely resembling that of our southern States. It grows to a height of nearly 10 feet. The fauna of Manga Reva is also extremely poor. There are no mammals, and, with the exception of a "sandpiper," no indigenous birds. Sea birds are few in number, and in our trip in the eastern Pacific we rarely had more than three or four birds accompanying us; often only one, and frequently none were visible for days. There are a few lizards on the islands, apparently the same species as those in the Society Islands.

We left Port Rikitea for Acapulco on the 4th of February to anchor off Aka Maru; on the 5th we left our anchorage, sounded off the east face of Manga Reva, and took photographs.

On our way north from Manga Reva to Acapulco we did not begin to trawl or tow until warned by the surface nets that the surface was becoming richer in animal and vegetable life, and also by the surface temperatures indicating that we had reached the southern edge of the cold western equatorial current. A little north of 10° south latitude we made our first haul and deep tow, and found a very rich pelagic surface fauna down to the 300-fathom line; recalling the pelagic fauna of the eastern lines and fully as rich. On trawling we found, as we expected, a very rich bottom fauna.

Among the animals brought up in the trawl were some superb Hyalonemas, siliceous Sponges, Benthodytes, and other deep-sea Holothurians; fine specimens of Freyella, and some large Ophiurans. This haul is interesting as showing that in the tract of a great current, with

abundance of food, we may find at a very considerable depth (2422 fathoms) an abundant fauna at very great distances from continental lands. We were, at this station, about 2140 miles from Acapulco, 1200 miles from Manga Reva, 1700 miles from the Galapagos, and about 900 miles from the Marquesas.

Another haul made under the equator, near the northern edge of the cold current, in 2320 fathoms, gave us the same results. The pelagic life was very abundant, the surface teemed with Radiolarians, Diatoms, and Globigerinae, and swarmed with invertebrates. The trawl contained a superb collection of Holothurians, Brisinga, Hyalonema, Neusina, and on this occasion we brought up the only Stalked Crinoid collected during this expedition, parts of the stem of two specimens of Rhizocrinus, of which, unfortunately, the arms were wanting.

Our progress, which had been excellent during the first days of our journey after leaving Manga Reva, has for the past six days been greatly impeded by head winds in the region where we ought to have been in the full swing of the southeasterly trades. This led us with great reluctance to abandon all idea of further work in the equatorial belt of currents, to give up our proposed visit to Clipperton, and on account of our limited coal supply to make for Acapulco, merely sounding every morning. This was a great disappointment to me, as we had every reason to expect to be able to spend some time in the belt of the equatorial currents, and settle more conclusively than we have been able to do, the question of their influence upon the richness of the fauna living in their track far from continental shores or insular areas.

The presence of Diatoms in all parts of the Humboldt current which we crossed from south of Callao to the equator at the Galapagos, and west towards Clipperton, shows how far the tract of a great oceanic current can be traced, not only by its temperature, but also by the pelagic life living upon its surface or near it. When once in the warm westerly equatorial current, the Diatoms disappear and the bottom samples show only surface Radiolarians and Globigerinae.

We took a number of serial temperatures in the line Galapagos to Manga Reva, passing from the colder water of the Humboldt current to the warmer waters south toward Manga Reva. The temperatures at 200 fathoms became nearly identical. North the great change in temperature took place between 25 and 200 fathoms, where there was a difference of 24°. South the warm water extended to 100 fathoms, a great change occurring between 100 and 200 fathoms, a drop of 16°. The serial temperatures taken at the southern and northern edges of the cold cur-

rent on the line Manga Reva to Acapulco agreed well with those taken in the same current to the east.

The samples of the bottom obtained by the soundings taken by the expedition or gathered in the mud-bag and in the trawl indicate that an immense area of the bottom of the eastern Pacific is covered by manganese nodules, and that they play an important part in the character of the bottom, not only in the area covered by this expedition, but also that the area of manganese nodules probably extends to the northwest of our lines to join the stations where in 1899 manganese nodules were found by the "Albatross" in the Moser Basin, on the line San Francisco to Marquesas. This area may also extend south of our line Callao to Easter Island, and join the line west of Valparaiso where the "Challenger" obtained manganese nodules at many stations. I do not mean to imply that the manganese nodules are present to the exclusion of Radiolarians and of Globigerinae. It is probable that the layer of nodules is partly covered by them, and by the thick sticky dark chocolate-colored mud which is found wherever manganese nodules occur.

During this expedition we sounded every day while at sea, and developed very fairly that part of the eastern Pacific which lies to the south and west of the line from Cape San Francisco to the Galapagos and west of a line Galapagos to Acapulco, limiting an area occupied by the "Albatross" in 1891. The area developed by us is included by a line 3200 miles in length from Acapulco to Manga Reva, and north of a line from Manga Reva to Easter Island and from Easter Island to Callao. We developed on our line Galapagos to Manga Reva the western extension of the Albatross plateau, and found it of a depth varying from 1900 to somewhat less than 2300 fathoms in a distance of nearly 3000 miles; but about half-way from the Galapagos to Manga Reva we came upon a ridge of about 200 miles in length with a depth of 1700 to 1055 fathoms, dropping rapidly to the south to over 1900 fathoms. I propose to call this elevation the "Garrett Ridge."

Our line from Manga Reva to Acapulco continued to show the western extension of the almost level bottom of the eastern Pacific. In a distance of 3200 miles the depth varied only about 400 fathoms. This great area of the eastern Pacific was practically a *mare incognitum*. Three soundings in latitude 20° S. toward the Paumotus and five soundings in a northwesterly trend from Callao to Grey's Deep are all the depths that were previously known in this great expanse of water.[1] The

[1] These soundings were made (one) by the Italian S. "Vittor Pisani" in 1882; (three) by the "Silverton" in 1893; (four) by the U. S. S. "Alaska," and two east of the Paumotus by the H. B. M. S. "Alert."

existence of the great plateau dividing Barker Basin along the South American coast from Grey and Moser Basins to the west is most interesting. It recalls the division of the southern Atlantic into an eastern and western basin by a central connecting ridge (The Challenger Ridge). The Albatross plateau joins the western extension of the Galapagos plateau, as developed by the "Albatross" in 1891.

The existence of a sounding of 2554 fathoms near the equator in longitude 110° W. would seem to indicate a small basin included in this plateau, disconnected from Grey's Deep and Moser Basin by its extension to the west. How far west towards these basins that extension reaches, no soundings indicate as yet. It is interesting to note that along the Mexican coast there are a number of deep basins lying disconnected close to the shore, just as there are a number of disconnected deeps close to the South American coast extending from off Callao to off Caldera, Chili, opposite high volcanoes or elevated chains of mountains. These basins are deeper than the Albatross plateau to the south, and form a deep channel separating in places the plateau from the steep continental slope. The steepness of a great part of the Mexican continental shelf is well seen, especially off Acapulco and Manzanilla. One of the small basins along the Mexican coast with 2661 fathoms lies off Sebastian Viscaino Bay; another with more than 2900 fathoms is to the west of Manzanilla Bay; a third to the southeast of Acapulco has about the same depth,[1] and a fourth with 2500 fathoms is off San Jose, Guatemala. These basins off the west coast, close to the shore and at the foot of a steep continental slope, are in great contrast to the wide continental shelves which characterize the east coast of Central America and the east coast of the United States.

The collections made during the present expedition will give ample material for extensive monographs on the Holothurians, the siliceous Sponges, the Cephalopods, the Jelly-fishes, the pelagic Crustacea, Worms and Fishes of the eastern Pacific, as well as on the bottom deposits and on the Radiolarians and Dinoflagellates, Diatoms, and other Protozoa collected by the tow nets. Small collections of plants were made at Easter Island and Manga Reva which may throw some light on the origin and distribution of the flora of the eastern Pacific.

[1] The last sounding we made off Acapulco in 2474 fathoms 29 miles south of the Light House showed the western extension of this deep hole.

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows: —

E. EHLERS. The Annelids of the "Blake."
C. HARTLAUB. The Comatulæ of the "Blake," with 15 Plates.
H. LUDWIG. The Genus Pentacrinus.
A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
R. T. HILL. On the Geology of the Windward Islands.
W. McM. WOODWORTH. On the Bololo or Palolo of Fiji and Samoa.
AGASSIZ and WHITMAN. Pelagic Fishes. Part II., with 14 Plates.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows: —

A. AGASSIZ. The Pelagic Fauna.
" The Panamic Deep-Sea Fauna.
K. BRANDT. The Sagittæ.
" The Thalassicolæ.
C. CHUN. The Siphonophores.
" The Eyes of Deep-Sea Crustacea.
W. H. DALL. The Mollusks.
H. J. HANSEN. The Cirripeds.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
HAROLD HEATH. Solenogaster.
R. VON LENDENFELD. The Phosphorescent Organs of Fishes.
H. LUDWIG. The Starfishes.
J. P. McMURRICH. The Actinarians.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
M. P. A. TRAUSTEDT. The Salpidæ and Doliolidæ.
H. B. WARD. The Sipunculids.
W. McM. WOODWORTH. The Nemerteans.
" The Annelids.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to XLII., and also Vols. XLIV., XLV., and XLVII; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVIII., XXIX., and XXXI.

Vols. XLIII., XLVI., and XLVIII. of the BULLETIN, and Vols. XXV., XXVI., XXVII., XXX., XXXII., and XXXIII. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Professors and Assistants of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation: —

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, in charge of Professor N. S. Shaler.

These publications are issued in numbers at irregular intervals; one volume of the Bulletin (8vo) and half a volume of the Memoirs (4to) usually appear annually. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Librarian of the Museum of Comparative Zoölogy, Cambridge, Mass.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. XLVI. No. 5.

THE VERTEBRATA OF GORGONA ISLAND, COLOMBIA.

INTRODUCTION. MAMMALIA.

By Outram Bangs.

PHYSICAL ASPECT AND CLIMATE; FAUNA.

By Wilmot W. Brown, Jr.

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CONTENTS.

I. Introduction. By Outram Bangs.

In February, 1904, John E. Thayer, Esq., equipped and put into the field the well-known zoölogical collector, Mr. Wilmot W. Brown, Jr. Some little-known regions in Panama and northern South America were selected for the season's work.

One of the places visited was Gorgona Island. The biota of this island is practically unknown; so far as I can find out the island has never been visited by a naturalist, though Captain Kellett and Lieutenant Wood apparently stopped there many years ago on their way to the Galapagos. The Catalogue of Birds in the British Museum (Vol. 11, p. 215) mentions a tanager, *Tachyphonus delattrii* Lafr., taken on Gorgona by these officers.

From its isolated position and its unlikeness to the adjacent mainland it was anticipated that Gorgona would prove a most interesting field. The results, however, are disappointing, for although many of the reptiles, birds, and mammals are very peculiar, the conditions that prevail seem singularly unsuited to support a rich and varied vertebrate fauna.

Mr. Brown remained upon the island about two weeks, June 19 to July 2, 1904.

A word as to the disposition of the specimens. The mammals, reptiles, amphibians, and fishes Mr. Thayer presents to the Museum of Comparative Zoölogy. Of the birds Mr. Thayer retains for his museum at Lancaster, Mass., those that particularly interest him, chiefly North American migrants; a small series of each species he has kindly given

[1] Papers from the John E. Thayer Expedition of 1904, No. 1.

to me; and of the remainder — the bulk of the material — a pair or two of each species has been selected and will be presented to the United States National Museum; the remainder is given to the Museum of Comparative Zoölogy.

An annotated list of the fishes collected by Mr. Brown, and identified by Mr. Samuel Garman will be given in the paper on the Panamic vertebrates.

II. Physical Aspect and Climate; Fauna. By Wilmot W. Brown, Jr.

Gorgona Island was probably discovered and named by Pizarro, as history tells us that he and his hardy band of followers, after leaving Gallo Island, retreated to Gorgona Island, where they fortified themselves and lived for five months, enduring great hardship. Finally the ship sent from Panama to their aid reached Gorgona, and Pizarro and his companions sailed for Tumbez Bay on the coast of Peru.

Gorgona Island, politically a part of the Republic of Colombia, is the private property of Don Pyan Cuevas, of Buenaventura. It is uninhabited; fishermen occasionally visit it for a few days at a time. It is five miles long by about half a mile wide, and lies N. N. E. by S. S. W., about twenty miles off Punta las Reys, the nearest point on the Colombian coast. The rise and fall of the tide is ten feet, and the current of the island sets off to the northeast. The water between the island and the coast of Colombia is said to be deep.

Gorgona, apparently of volcanic formation, consists of three peaks; the highest, and central one, is some 800 feet in altitude. The three hills make the island very conspicuous from the ocean, and form a pleasant contrast to the low, swampy mainland opposite. In clear weather the high peaks of the distant Andes can be seen. It is completely wooded with a dense tropical forest without trails or open places, and is well watered by numerous streams.

Rain falls continuously throughout the year, there being no dry season, and heavy electric storms are of daily occurrence. The excessive moisture entailed much personal inconvenience and hardship, and the collections made were preserved by artificial heat and constant vigilance. In my attempts to preserve botanical specimens I wholly failed.

Collecting was done under great difficulties; at low tide one could walk along the beaches, but high water reaches to the very forest, and every step inland had to be cut with machetes through the dense, saturated jungle.

The fauna of the island is extremely poor. There are very few birds, either in numbers or in species; in a day's tramp perhaps from six to ten birds may be seen. Mammals also are scarce, and with the exception of the spiny rat, no small rodents were found. Land crabs swarmed and proved a great annoyance, eating up or injuring most of the spiny rats caught; they also carried off the bait about as soon as a trap was set. Snakes of several species were not uncommon, and two small frogs were abundant in the woods. The waters around the island swarmed with fish, and whales were very abundant, the vicinity of the island being a favorite feeding-ground during the summer months.

At the southwestern extremity of the island there is a peninsula about a mile long, called Gorgonilla; at high water Gorgonilla is essentially an island. Here boobies of two species and man-o'-war birds breed in great numbers. At the time of my visit they were not nesting, though they were present in considerable numbers, roosting or resting between the times they were at sea fishing.

III. Mammalia. By Outram Bangs.

Apart from two bats, Mr. Brown found but three species of mammals, — a monkey, a spiny rat, and an agouti. The first two are peculiar and new; the agouti, however, I am not able to distinguish from *Dasyprocta variegata*, though the only specimen taken is too young to be identified with absolute certainty.

Mr. Brown feels confident that no small terrestrial mammals occur in Gorgona, not only because he trapped assiduously without getting any, but because the rain-soaked condition of the ground and underbrush throughout the year seems to preclude any chance of their occurrence.

Dr. Glover M. Allen has very kindly helped me identify the bats.

All the measurements are in millimetres, and the colors are according to Ridgway's nomenclature.

OCTODONTIDAE.

1. Proechimys gorgonae, sp. nov.

Type. — Mus. Comp. Zoöl. No. 10,828, old ad. ♂, Gorgona Island, July 2, 1904.

Seven specimens, adults and young, June 25 to July 2, 1904.

Characters. — Apparently nearest *P. centralis panamensis* Thomas, but very different in color, being very dark above and with the under parts not wholly white. Skull very similar to that of *P. centralis panamensis*, from which it can

only be separated by the slightly larger, wider, and longer palatal foramina and rather heavier molars. The nasals are pointed posteriorly as in that form, by which character the skull can be distinguished from that of *P. centralis chiriquinus* Thomas or *P. burrus* Bangs. The rostrum is rather heavy, less decurved, and rather straighter than in *panamensis*.

Color and Pelage. — Spines confined to anterior two-thirds of back, not very numerous and rather softer than in allied forms; colors *very dark:* upper parts burnt umber, most of the hairs as well as the spines tipped with black; head, top of nose, and cheeks chiefly blackish, slightly varied with Vandyke brown; sides a little paler than back and with fewer black tips to the hairs; under parts white only along middle of belly, the under surface of legs, arms, neck, anal region, and sides of belly being dull mars brown or russet; upper surface of feet and hands brownish black; tail black above, dull gray below, well clothed with short, stiff hairs; ears black. Young similar to adults, but still darker, having a pronounced black dorsal band.

Measurements —

No.	Sex.	Total length.	Tail vertebrae.	Hind foot.	Ear.
10,828	♂ old ad.	427	150	60	23
10,829	♂ old ad.	365	90[1]	55	22
10,834	♀ adult	405	140	53	23
10,830	♂ young ad.	409	123	53	20
10,831	♂ young	340	120	50	20
10,832	♂ young	327	120	52	20

Skull. — Type, old adult ♂: Basal length, 59; occipito-nasal length, 65; zygomatic width, 30.4; mastoid width, 23.8; least interorbital width, 13; length of nasals, 25; width of nasals, 7.2; length of palate to palatal notch, 22.6; length of palatal foramina, 5.8; upper tooth row, 10.2; length of single half of mandible, 35.4; lower tooth row, 10.2.

Remarks. — The spiny rat was not uncommon in Gorgona Island, and a much larger number were trapped than could be preserved, as the crabs ate them up as soon as caught.

The form is very well marked, so far as color goes, in its blackish upper parts and the small amount of white on the belly, being very different from the other forms of this group, all of which are reddish brown above and pure white below. The skull, however, does not appear to differ markedly from that of *P. centralis panamensis*, which is probably the nearest ally of the present island form.

DASYPROCTIDAE.

2. Dasyprocta variegata Tschudi.

One young ♂. This specimen is unfortunately too young to identify positively, but it seems to belong to this species.

[1] Tip of tail gone.

PHYLLOSTOMATIDAE.

3. Micronycteris megalotis Gray.

One adult ♂. June 28.

4. Dermanura rava Miller.

One male, July 1st.

CEBIDAE.

5. Cebus curtus, sp. nov.

Type. — Mus. Comp. Zoöl., No. 10,824, adult ♂, Gorgona Island, July 2, 1904.

Two specimens, ♂ ♀ July 2, 1904.

Characters. — A small, short-tailed island form, related to *C. hypoleucus* (Humbt.). Similar in color to *C. hypoleucus*, — black all over except head, under surface and sides of neck and shoulders, which are white in the male and Isabella color in the female. Differs from *C. hypoleucus* in being smaller: tail very much shorter; hands, feet, and limbs shorter. Skull smaller and narrower, especially so across the orbits and just behind them.

Measurements —

No.	Sex.	Total length.	Tail vertebrae.	Hind foot.
10,824	♂ ad.	753	420	115
10,825	♀ young ad.	753	420	112

Skull. — Type, adult ♂: Basal length, 69; occipito-nasal length, 80.4; zygomatic width, 58.4; mastoid width, 48.2: width across orbits, 49.2; least width behind orbits, 38.4; length of palate to palatal notch, 33.6; palatal notch to foramen magnum, 28; upper tooth row, canine to last molar, 25; length of mandible, 58; lower tooth row, canine to last molar, 28.

Remarks. — The monkey of Gorgona Island is a well-marked species, differing greatly from *Cebus hypoleucus* in its very short tail, and much smaller hands and feet. The limbs, also, judging from skins made in the same way, appear to be very short, and the skull shows characters by which it can be separated from that of *C. hypoleucus.*

It was not uncommon in the forest, but was hard to reach owing to the denseness of the jungle.

IV. Aves. By John E. Thayer and Outram Bangs.

The paucity in the ornis of Gorgona Island is well shown by the following list of sixteen species. Mr. Brown took examples, during his stay of two weeks, of but fourteen species, and of these several are represented by only from one to three individuals each. The small amount of preparation gave Mr. Brown more time for field work, and he tells us he often

stayed out all day shooting every bird he saw, and even at that never got more than ten birds in a single day.

Two species only, the yellow honey creeper and the ant shrike, were even fairly common; all other land birds were in such small numbers that of several of them he saw but one or two individuals during his stay on the island.

Owing to the dense jungles that completely cover the island, it was very hard to get about, and the birds were all in the high trees, so that it is very possible Mr. Brown did not procure all the species that occur there.

In spite of the late date, June and July, at which the island was visited, the birds are in excellent plumage, showing no signs of wear or fading. In a wet, heavily forested island such as Gorgona, the plumage of the birds appears to keep in fine condition up to the very time they moult, in marked contrast to what happens in dry, hot, barren regions.

The four species of land birds we describe as new are strongly characterized, and additional material might show that one or two of the others also represent new island forms. The new booby is quite different from either *Sula leucogastra* or *Sula brewsteri*, though somewhat intermediate between them. We give it specific rank, because the only alternative is to consider *S. leucogastra*, *S. brewsteri*, *S. nesiotes*, and the new form subspecies of one bird, which we are not quite prepared to do.

We are under great obligations to Dr. Robert Ridgway, who, though extremely busy at the time, compared many of the specimens with the material in the United States National Museum, and also to Mr. E. W. Nelson for comparing the boobies with typical specimens in the United States Biological Survey Collection.

All the measurements are in millimetres, and the colors are according to Ridgway's nomenclature.

SULIDAE.

1. Sula nebouxi Milne Edwards.

One immature ♂, June 26.

Earlier in the season this species breeds abundantly on Gorgonilla, according to information given Mr. Brown by the fishermen who visit the island.

2. Sula etesiaca, sp. nov.

Type. — Coll. E. A. & O. Bangs, No. 14,026, adult ♂, Gorgona Island, June 29, 1904.

Five specimens, adults ♂ ♀, June 29 to July 2, 1904.

M. C. Z., No. 40,280, adult ♀, Gorgona Island, July 1, 1904.

Characters. — Size about as in *Sula brewsteri* Goss. Intermediate in color and color-pattern between *S. brewsteri* and *S. leucogastra*; in the adult ♂ of

the new bird the forward part of the head only is gray, shading into the dark sooty brown of the rest of upper parts at nape, on cheeks and on throat just below the gular sack (in *S. brewsteri* the adult ♂ has the head entirely whitish and the neck ashy gray shading into color of back at shoulders). The female of the new form has the whole head and neck, dark sooty brown concolor with the back, like *Sula leucogastra* (the female of *S. brewsteri* has the head and neck distinctly lighter or grayer than the back). Young as well as adult examples are darker brown than specimens of *S. brewsteri* in corresponding plumage.

Colors of Naked Parts in Life. — Adult ♂: Bill dusky, slightly yellowish toward base; gular region and skin around eye dusky, sometimes tinged with greenish yellow; tarsus and foot pea-green. Adult ♀: Bill, gular region, skin around eye, tarsus, and foot sulphur yellow.

Measurements —

No.	Sex.	Locality.	Wing.	Tail.	Tarsus.	Culmen.
14,026	♂ ad.	Gorgona Isl.	374	187	47	95
14,251	♂ ad.	Saboga Isl.	380	186	45	95
14,252	♂ ad.	San Miguel Isl.	379	168	45	94
14,027	♀ ad.	Gorgona Isl.	398	198	47	97
14,028	♀ ad.	do.	405	197	50	100
14,253	♀ ad.	Saboga Isl.	400	192	48	100

Geographic Distribution. — *Sula etesiaca* is not confined to Gorgona Island, but breeds also in great numbers on Saboga Island, — the "bird rock" of the Pearl Islands in the Bay of Panama, — Mr. Brown securing a large series on the present trip at the last-named place. Cocos Island, between Panama and the Galapagos, is another breeding place, Mr. Nelson informing us that specimens in the National Museum from this island are identical with ours from Gorgona and the Pearl Islands.

Remarks. — Mr. E. W. Nelson has most kindly compared our birds with the fine series of true *S. brewsteri* taken by himself and Goldman on the west coast of Mexico and adjacent islands, and agrees with us that the present form is well worthy of recognition. Whether it should be treated as a distinct species or all the forms like *Sula leucogastra* arranged as subspecies of one bird, is a matter best to be left for a detailed revision of the group.

Sula etesiaca breeds in large numbers on Gorgonilla; at the time Mr. Brown visited the place the breeding season was over, though the birds were still abundant about the island.

FREGATIDAE.

3. Fregata aquila (Linné).

No specimens were secured. The breeding season was past and the birds could not be obtained. It nests in numbers on Gorgonilla.

ARDEIDAE.

4. Butorides striata (Linné).

Three specimens, June 24 to July 2, all in the striped immature plumage. They agree minutely with a skin from Surinam in corresponding plumage with which we have compared them.

FALCONIDAE.

5. Urubitinga subtilis, sp. nov.

Type. — Coll. E. A. & O. Bangs, No. 14,001, adult ♂, Gorgona Island, July 1, 1904.

Two specimens, adult ♂, July 1, 1904; juv. ♂, June 19, 1904.

Characters. — Somewhat similar to *U. anthracina* (Licht.), but smaller (wing nearly two inches shorter); white central tail band and terminal margin narrower; in color the new form differs from *U. anthracina* in having the ground color of the broad mottled band extending across the secondaries, bright cinnamon rufous, this band in true *U. anthracina* having the ground color dull grayish only tinged with rufous on the inner edges of some of the feathers; the young skin has the wings much marked and spotted with cinnamon rufous — much more so than in any of the many specimens of *U. anthracina* we have examined.

Measurements —

No.	Sex.	Wing.	Tail.	Tarsus.	Culmen.
14,001	♂ ad.	330	187	87.5	38.5
14,002	♂ young	324	188	84	38

RALLIDAE.

6. Ionornis martinica (Linné).

One adult ♂, June 23.

This specimen shows no peculiarities. It agrees exactly with skins from various localities in North and Middle America.

CUCULIDAE.

7. Coccyzus melanocoryphus Vieill.

One adult ♀, June 23. This specimen is perfectly typical of the species.

TROCHILIDAE.

8. Amizilis tzaeatl (Llave).

Three specimens, all females, June 24 to July 2. These are not to be distinguished from continental specimens.

FORMICARIIDAE.

9. Thamnophilus gorgonae, sp. nov.

Type. — Coll. E. A. & O. Bangs, No. 14,005, adult ♀, Gorgona Island, July 1, 1904.

Twenty-four specimens, adults ♂ ♀, June 23 to July 2, 1904.

M. C. Z., Nos. 40,281–40,290, adults ♂ ♀, June 23 to July 2, 1904.

Characters. — Nearest to *T. naevius* (Gml.), but slightly larger, tail longer, and bill relatively smaller. Adult ♂ similar in color to that of *T. naevius*, but paler gray below, and more whitish in middle of belly — intermediate in color between the males of *T. naevius* and *T. ambiguus* Swains. Adult ♀ quite different in color from females of these two species, though somewhat intermediate between them. From the ♀ of *T. naevius* it differs in being much paler and much more reddish brown; the general color much as in *T. ambiguus*, except that in that species the pileum and tail are strongly rufescent.

Color. — Adult ♀, upper parts reddish raw umber, slightly more rufescent on crown; wings blackish, the primaries edged with raw umber, secondaries with buff and lesser coverts tipped with buff; outer scapulars edged externally with whitish; tail raw umber, all the feathers except central pair with a white terminal spot, the central ones with a tiny buff spot in the middle of the tip, the outer pair with another spot, buffy white, on the outer web midway of feather; under parts pale raw sienna on throat and middle of belly and under tail coverts and shading to tawny-olive on sides; a large semi-concealed white patch on back.

Measurements —

No.	Sex.	Wing.	Tail.	Tarsus.	Culmen.
14,003	♂ ad.	70.5	57	21.5	19
14,004	♂ ad.	75	58	22	19
40,281 M. C. Z.	♂ ad.	73	57	21	17.5
40,282 M. C. Z.	♂ ad.	71.5	54	22	20
C.	♂ ad.	71	54	21	19.5
D.	♂ ad.	70.5	54.5	21	18.5
40,283 M. C. Z.	♂ ad.	70.5	54	21.5	18
F.	♂ ad.	72	56	21.5	19
G.	♂ ad.	70	56	22	19.5
40,284 M. C. Z.	♂ ad.	72	55	22	20
14,005	♀ ad.	72	53.5	22	18.5
14,006	♀ ad.	68.5	51.5	22	19
I.	♀ ad.	72	55	21.5	18.5
J.	♀ ad.	69.5	53	22.5	20
K.	♀ ad.	68	55	22	18.5
40,285 M. C. Z.	♀ ad.	68	56.5	22	19
40,286 M. C. Z.	♀ ad.	68.5	54	22	20
40,287 M. C. Z.	♀ ad.	72	56	22	18.5
40,288 M. C. Z.	♀ ad.	71	56.5	22.5	18
P.	♀ ad.	68.5	56	22	20

TYRANNIDAE.

10. Tyrannus melancholicus satrapa (LICHT.).

One adult ♂, July 1. Another, a nestling, was shot, but was so mangled that it could not be saved. The adult agrees in all respects with continental skins, except that the under tail coverts are much more clouded with dusky than usual. In an enormous series of this form from Central and northern South America, not one has the under tail coverts marked with dusky to such an extent, though many show traces of such markings.

COEREBIDAE.

11. Cyanerpes gigas, sp. nov.

Type. — Coll. E. A. & O. Bangs, No. 14,007 juv. ♂, Gorgona Island, June 26, 1904.

Three specimens, 2 juv. ♂, 1 adult ♀, June 26–28, 1904.

Characters. — A very distinct species, though nearly related to *C. cyaneus* (Linné). Size very large; tail very long; bill short and stout; the purplish color of rump and outer scapulars in the ♂ very much darker — more purple, less blue — than in *C. cyaneus.* Female much darker and duller green.

Color. — Male, type (not quite fully adult, the breast and sides still retaining some of the green feathers of the immature plumage, and the crown mainly green, the turquoise-colored feathers of the adult plumage appearing irregularly through it), similar in distribution of colors to the male of *C. cyaneus;* the under parts slightly darker — cyanine blue; rump, upper tail coverts, and outer scapulars much darker than in *C. cyaneus* and of a different shade, being about the same shade as under parts, — cyanine blue.[1] Adult female, upper parts dark, dull green (nearer to parrot green of Ridgway than any of his colors, but duller and more dusky); under parts decidedly darker and duller than in *C. cyaneus* and less tinged with yellowish on throat and middle of belly.

Measurements —

No.	Sex.	Wing.	Tail.	Tarsus.	Exposed culmen.
14,007	♂	68.5[2]	42	16	16
A.	♂	66[2]	43	16	16.5
14,008	♀	67.5	42	16.5	16.5

Remarks. — This species is much more distinct from *C. cyaneus* than the above description and measurements seem to imply. In general bulk it is a

[1] In Birds of North and Middle America, Part II. p. 386, Ridgway describes the ♂ of *Cyanerpes cyaneus* as though the rump and the under parts were the same color, — smalt blue. In a very large series examined by us, the rump is invariably paler and brighter blue than the under parts, about French blue.

[2] In these two skins the wing measurement is much too short, as the longer primaries having recently moulted are not full grown.

much larger bird. The much darker and duller blue of the rump in the male is very striking, and the dull, dusky green of the upper parts in the female is wholly different from the paler and more olive green of these parts in *C. cyaneus*.

Cyanerpes cyaneus has, according to Ridgway, never been recorded from any point in South America west of the Andes, so that the form inhabiting Gorgona Island appears to be widely separated geographically from that species. It must, however, be borne in mind that very little is known about the ornis of the western coast of Colombia opposite Gorgona Island.

12. Coereba gorgonae, sp. nov.

Type. — Coll. E. A. & O. Bangs, No. 14,009, adult ♂, Gorgona Island, June 28, 1904.

Thirty specimens, adult ♂ ♀, 1 juv. ♂, June 23–July 2, 1904.

M. C. Z., Nos. 40,291–40,306, adults ♂ ♀, Gorgona Island, June 24 to July 2, 1904.

Characters. — A very distinct species, nearest to *C. cerinoclunis* Bangs of the Pearl Islands, Bay of Panama. Differing in the much smaller — reduced to a mere dot — white wing spot, much deeper black back, darker gray throat, darker and more greenish yellow belly, and in having a greenish band bordering the gray of throat below. Size about the same.

Color. — Adult ♂, upper parts deep sooty black, a broad white superciliary stripe extending from nostril to beyond auricular region; rump patch olive yellow; malar region, chin, and throat dark gray (almost slate-gray, No. 5, of Ridgway), the malar region distinctly freckled with dusky; below the gray of throat, an ill-defined band of dull oil green, which separates the gray of the throat from the yellow of the breast; rest of under parts gamboge yellow with a greenish tinge, passing into yellowish olive on flanks; under tail coverts buffy white; lateral rectrices broadly tipped with white on inner webs, nearly as broad as in *C. luteola*; white wing spot reduced to a mere trace on the three or four primaries next the outermost. Female similar, perhaps averaging slightly paler and duller. Young differs from the adult in having the throat yellowish and the back duller and browner.

Measurements —

No.	Sex.	Wing.	Tail.	Tarsus.	Culmen.
14,009	♂ ad.	57	31	17	13
14,010	♂ ad.	55.5	34	16	13
14,011	♂ ad.	57.5	32.5	17	13.5
14,012	♀ ad.	53	30.5	16.5	12.5
14,013	♀ ad.	52	29	17	12
A.	♀ ad.	53	30	16	13

Remarks. — This fine island species can be separated at once from all its allies by the very small white wing spot, the greenish band below the gray throat, and the dusky freckling of the malar region. In its dark gray throat

and jet black upper parts it resembles *C. luteola*, but otherwise the likeness is not very close, and the species is very strongly characterized.

TANAGRIDAE.

13. Calospiza lavinia (Cassin).

Three specimens, two males and a female, June 25–27.

These agree minutely with continental examples, in color and general proportions, except that the bill is shorter and relatively broader. This character, though strongly marked in these three specimens, might fail in a larger series, and we prefer, for the present at least, to allow the Gorgona bird to stand as true *C. lavinia*.

14. Tachyphonus delattrii Lafr.

Not met with by Mr. Brown. The species is recorded from Gorgona Island by Sclater in Catalogue of Birds in the British Museum, Vol. 11, p. 215, one adult ♂ having been procured there by Captain Kellett and Lieutenant Wood.

FRINGILLIDAE.

15. Sporophila gutturalis (Licht.)?

One adult ♀, July 1.

This skin comes nearer to the ♀ of *S. gutturalis* than to females of *S. luctuosa* and *S. collaris* (the females of these three species all look much alike), but probably really represents a distinct form, as it is much smaller — shorter wing and tail and smaller feet — and slightly darker in color. Without a male, however, it is impossible to decide just what it really is. Its measurements are as follows: No. 14,015 ♀, wing, 50.5; tail, 36.5; tarsus, 13.5; culmen, 7.

16. Sporophila telasco (Lesson)?

One young ♂, July 1.

This specimen seems to be referable to *S. telasco* of Peru and Ecuador. At all events, it needs comparison with no other species. We can find no skins of *T. telasco* in quite corresponding plumage to compare it with, but on the other hand can detect in our specimen no marked differences from the fully adult skins with which it has been compared. Our specimen is immature, the bright chestnut throat patch of the adult plumage being indicated by feathers of this color appearing irregularly over the throat.

V. Reptilia and Amphibia. By Thomas Barbour.

The Reptiles of Gorgona Island are derived from the adjacent mainland. Many of the species, however, are very distinct from their nearest congeners.

The two representatives of the *Geckonidae* are indistinguishable from widely spread mainland forms. One notes with surprise the fact that no *Sphaerodactylus* occurs in the collection. Of the *Iguanidae* the *Anolis*, though quite different from, is probably a modification of, *A. andianus*. The series of *Basiliscus americanus* and the single young *Iguana tuberculata* are typical of their respective species. Dr. Stejneger has very kindly examined the *Enyalioides* and the two amphibians. For this kindness I wish to thank him. He considers *E. heterolepis* as the nearest relative of *E. insulae*. The specimens of *Ameiva* show a constant difference from *A. bridgesii*, in the weak carination of the dorsal scales. With only four specimens from Gorgona Island, and these all of the same age, it hardly seems desirable to name the island specimens.

Of the snakes, the Green Tree Snake (*Leptophis occidentalis*) differs sufficiently to warrant its being considered a new subspecies. The *Spilotes* agrees well with Günther's figure of *S. argus* in the Biologia Centrali-Americana. The *Leptodeira* belongs to a wide-ranging species of the Continent.

Owing to the luxuriant vegetation, Mr. Brown used his gun very freely in collecting reptiles, and there are several specimens so imperfect that they cannot be identified, but which lead one to believe that there are other new forms, besides those described.

Reptilia.

GECKONIDAE.

1. Gonatodes fuscus (Hallowell).

Nine typical examples.

2. Gonatodes caudiscutatus (Günth.).

Four examples.

IGUANIDAE.

3. Anolis gorgonae, sp. nov.

Types. — Mus. Comp. Zoöl., No. 6,984, Gorgona Island.

Three specimens nearly related to *A. andianus* Blgr. From this species it differs in having five rows of loreal scales, no tricarinate supraoculars, and six labials to below the centre of the eye. The hind limb is longer than in the continental species.

Ear opening medium and round. Body hardly compressed. Ventrals small, but considerably larger than the dorsals and strongly imbricate. The appressed hind limb reaches a point halfway between the orbit and the tip of

the snout. Digits considerably dilated, 16 lamellae under phalanges II and III of the fourth toe. Tail somewhat compressed, covered with rather large, equal, strongly keeled scales.

Color. — Bright purple above, lower surfaces lighter and buffish. Gular appendage large, whitish, with lines and dots of lilac at the base. The under surfaces of the thighs are buff with indistinct wavy bands of pale lilac.

Head	16 mm.
Width of head	9 "
Body	51 "
Fore limb	33 "
Hind limb	60 "
Tibia	14 "

4. Basiliscus americanus Laur.

Sixteen examples of this widely spread species, which do not appear to differ from typical specimens from Panama.

5. Enyalioides insulae, sp. nov.

Types. — Mus. Comp. Zoöl., No. 6,983, Gorgona Island.

Two specimens, closely allied to *E. heterolepis* Bocourt. The ventral scales, however, are only very slightly keeled. The spinose lateral scales, considerably enlarged, form three longitudinal series on each side of the back. On the flanks are only a few scattered enlarged scales; these do not fall into vertical series, as is the case with *E. heterolepis.* The color of this island race is uniform rich mahogany brown above; ivory or creamy white below. There are forty-one distinct spiny whorls evident upon the tail, which is brown above and below at the tip.

Head	25 mm.
Width of head	20 "
Body	73 "
Fore limb	47 "
Hind limb	102 "
Tibia	35 "
Tail	165 "

6. Iguana tuberculata Laur.

A single young male.

TEIIDAE.

7. Ameiva bridgesii (Cope).

Four specimens agree perfectly with the descriptions of continental specimens, except that in these island examples the keels on the dorsal scales are obsolescent.

COLUBRIDÆ.

8. Spilotes guentheri (Blgr.).

S. argus Bocourt. Günth. Biol. C.-Amer. Rept. p. 118; pl. xliv (1894).

A single large specimen, with only a short stump of tail present, and with the yellow spots on the scales very irregularly arranged.

9. Leptophis occidentalis insularis, subsp. nov.

Type. — Mus. Comp. Zoöl., No. 6,985, adult, Gorgona Island, one specimen.

Scales $\frac{15}{171 + 165}$.

This island race is different from the continental form in that there are several dark brown or black spots, or short wavy lines, on each side of the carina of each scale. This carina is characteristically dark-colored. The scales on the tail are dark-edged; and this condition gives a reticulate condition.

10. Leptodeira albofusca (Lacep.).

A single example of this common species, with scales $\frac{23}{174 + 75}$, is the only one which Mr. Brown captured.

11. Lachesis lanceolatus (Lacep.).

Two young specimens, typically colored, have their scales arranged as follows: the smaller is 312 + 51 mm. in length, scales $\frac{27}{193 + 68}$; the larger is 369 + ? mm. long, scales $\frac{25}{195 + ?}$.

Amphibia.

RANIDAE.

12. Prostheraspis femoralis, sp. nov.

Types. — Mus. Comp. Zoöl., No. 2,422, Gorgona Island. Twenty-two specimens, all apparently adult.

Apparently closely related to *P. inguinalis* Cope. It differs in coloring and proportions. The tibio-tarsal articulation reaches somewhat beyond the eye. The color is gray above, sometimes with faint brown marblings. Below paler gray, frequently with rich markings of deep chocolate brown, these particularly abundant under the chin.

ENGYSTOMATIDAE.

13. Atelopus gracilis, sp. nov.

Types. — Mus. Comp. Zoöl., No. 2,423, Gorgona Island. Fourteen specimens, adults and juv.

Rather similar to *A. flavescens* Dum. and Bibr., the digital arrangements are the same. This island race, however, differs in the following points. First, the head is contained three times in the length of the trunk of an adult female, and two and one half times in an adult male. Secondly, the tibio-tarsal articulation reaches slightly beyond the anterior border of the eye. The color is very deep brown, with red-brown longitudinal stripes. In many examples there is a white lateral stripe running from the posterior border of the eye to the groin.

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25,564

Bulletin of the Museum of Comparative Zoology

AT HARVARD COLLEGE.

Vol. XLVI. No. 6.

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II.

DESCRIPTION OF A NEW GENUS OF ISOPODS, TYPICAL OF A PECULIAR FAMILY.

By Harriet Richardson.

[Published by Permission of George M. Bowers, U. S. Fish Commissioner.]

With One Plate.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

July, 1905.

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[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.

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II.

Description of a new genus of Isopods, typical of a peculiar family.

By Harriet Richardson.

In the recent voyage, 1904–05, of the Steamer "Albatross" to the Eastern Pacific a very peculiar Isopod was collected, which does not seem to belong to any of the known families of the order. Although it was found free and unattached, it is probably a parasite, owing to the fact that it presents marked degeneration in having lost all the abdominal appendages. It is also without eyes and has prehensile legs. I have made it the type of a new family, Colypuridae.

A few years ago,[1] Giard and Bonnier described a peculiar Isopod, *Rhabdochirus incertus*, which also lacks abdominal appendages. The abdomen, however, is not inserted under and covered by the last thoracic segment, as is characteristic of the present type. *Rhabdochirus incertus* also differs in having all seven segments of the thorax free, well developed antennae, and a differentiation in the thoracic legs, which are not prehensile, the three anterior pairs and the seventh pair being very much shorter, about half as long as the fourth, fifth, and sixth pairs. Giard and Bonnier were unable to place it in any of the known families of the order. I propose for this form the family Rhabdochiridae.

COLYPURIDAE.

Colypurus, gen. nov.

Head coalesced with the first thoracic segment. The following six thoracic segments free, the first four free segments increasing gradually in width backward. Seventh thoracic segment, or sixth free segment, longer than the others and rounded posteriorly.

[1] Bull. Soc. Ent. France, 1898, No. 9, pp. 198–200.

Abdomen unsegmented, conically tapered, reduced in size, devoid of appendages, and placed under the last thoracic segment, so that, in a dorsal view, only the extremity appears below the seventh thoracic segment.

All seven pairs of legs present, and prehensile in character.

Antennae rudimentary, composed of only a few articles and almost inconspicuous, being placed on the ventral side of the head and invisible in a dorsal view.

Colypurus agassizi, sp. nov.

Body gradually increasing in width backward from the first to the fourth free thoracic segment. The head is 2mm. wide, the first free thoracic segment is 3 mm. in width, and the fourth free segment measures 4 mm. The length of the body is 5 mm.

The head is produced in the middle anteriorly in a rounded lobe. The sides of the head are also expanded in rounded lobes. Four knob-like bodies are situated in a transverse series on the dorsal surface of the head, the two central ones being largest; the lateral knobs are placed one on each lateral lobe. The antennae are rudimentary, inconspicuous, composed of only a few articles, and not visible in a dorsal view. The tips of the mandibles project from the apex of the oral cone.

The first segment of the thorax is coalesced with the head and bears the first pair of legs. The following five segments are more or less subequal in length, but increase gradually in width to the fourth free segment. The last thoracic segment is longer than any of the preceding segments and is posteriorly rounded. Each thoracic segment bears a pair of prehensile legs, there being seven pairs altogether.[1]

The abdomen is inserted beneath the last thoracic segment, is conically tapered, unsegmented, and devoid of appendages.

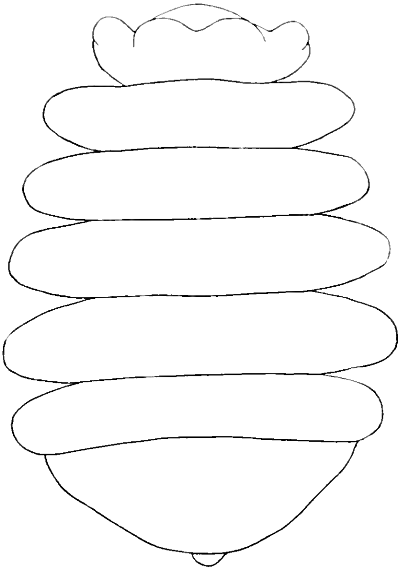
Only one specimen was collected in the Eastern Pacific by the Steamer "Albatross" in 1904–05 at station 4621. Lat. north 6° 36′; Long. west 81° 44′, off Mariato Point.

The type is in the Museum of Comparative Zoölogy.

[1] In the specimen the third leg on the right side is broken off about the middle.

COLYPURUS AGASSIZI.

1. — Dorsal view x $19\frac{1}{3}$.
2. — Ventral view x $19\frac{1}{3}$.



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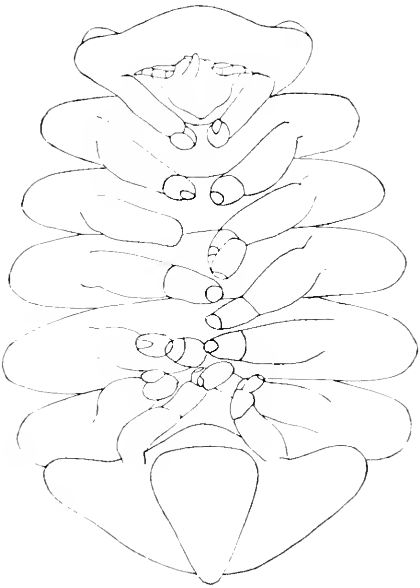

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Vol. XLVI. No. 7.

NOTES ON BERMUDIAN FISHES.

By Thomas Barbour.

With Four Plates.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

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September, 1905.

No. 7.—*Notes on Bermudian Fishes.*[1] By THOMAS BARBOUR.

THE material which forms the basis for this paper belongs to the Museum of Comparative Zoölogy and is from several sources: first, a collection made by my brother, Mr. W. W. Barbour, and myself during parts of March and April, 1903; secondly, a large and rather complete collection made during part of June, July, and part of August, 1903, while I was attached to the Biological Station at Flatts, Bermuda; thirdly, a number of specimens in the collections of the Museum of Comparative Zoölogy, and finally, a series obtained by Professor Mark and collected at the Station during the summer of 1904. I here express my gratitude to Dr. Mark for his kindness in procuring a number of most interesting specimens, and thank Messrs. H. B. Bigelow, Owen Bryant, and J. T. Nichols, for their kind aid in collecting and preserving the largest collection. Finally, it is a pleasure to thank Mr. Samuel Garman of the Museum for the assistance he has giving me in making the identifications.

Before turning to a systematic consideration of the material in hand, a few words are necessary in explanation of the peculiar faunal conditions which obtain about the Bermuda Islands. In 1872 Dr. G. Brown Goode visited the Bermudas for several weeks (February to March), and made the first collections of any considerable size or value from this locality. He pointed out in his paper on the fishes (Goode '76[a]) the splendid opportunity here presented to the ichthyologist for the study of the effects which the ocean currents have had in providing Bermuda with a fish fauna. He called attention to the fact that almost all the more characteristic fishes of the West Indian regions, and also many fishes which are found in the Azores, Canaries, Madeira, Cape de Verde Islands, and even on the coasts of Southern Europe and Africa are represented in Bermudian waters. One of the most interesting examples of distribution probably due to ocean currents is the occurrence of *Synodus saurus*, a fish which, on account of its sluggish, bottom-loving disposition, one would consider unlikely to range far from home. The majority of the

[1] Contributions from the Bermuda Biological Station for Research. No. 6.

species derived from distant regions, are, as Goode has pointed out, powerful and rapid swimmers. Few of the species which have been described as peculiar to Bermuda have remained so long. Both *Stolephorus choerostomus* and *Siphostoma jonesi* were once believed to be peculiar to Bermuda, but only a year or so ago the U. S. Fish Commission expedition to Porto Rico found both these species there. The Bermuda representatives were in all probability derived from the West Indian region. *Ulaema lefroyi* also is now known from many of the West Indies, and the Florida Keys.

The classic on the general Natural History of the Bermudas is Jones, Wedderburn, and Hurdis (**'59**); while more recently Verrill (: **02**) has published a most valuable and interesting volume dealing with the history, scenery, etc., of the island and on the faunistic changes due to man. In (: **01**) Verrill also published a paper dealing with the fauna; this contains a short article on the fishes. The birds and several groups of invertebrates have been treated in a volume by Jones and Goode (**'84**). An interesting popular account of the fish markets of Bermuda was published by Goode (**'76**[b]) in "Forest and Stream." Günther (**'79**) has listed the species of fishes taken by the naturalists of H. M. S. Challenger near the islands.

In the present paper the notes on distribution are obtained partly from "The Fishes of North and Middle America," by Jordan and Everman, which I have found very valuable in this connection, and partly from specimens in the vast collections of the Museum of Comparative Zoölogy.

LEPTOCARDII.

BRANCHIOSTOMATIDAE.

Branchiostoma caribbaeum Sundeval. The West Indian Lancelet.

Verrill, : **01**, p. 55.
Goode, **'77**, p. 293 (*B. lubricum*).

Distribution. — Atlantic coast of North America to Rio Plata.

Found in all localities where the bottom is suitable. Very common on the sandy spit in Flatts Inlet, directly opposite the Hotel Frascati.

Asymmetron lucayanum Andrews. Andrews's Lancelet.

Mark, : **04**, p. 179.

Distribution. — Bahamas and Bermudas.

Taken in dredgings at a number of localities in different parts of the Bermudas.

PLAGIOSTOMI.

GALEIDAE.

Carcharhinus platyodon (Poey). Puppy Shark.

Verrill, :**01**, p. 55.

Distribution. — Coasts of Texas and Cuba.

Very common off the Challenger Banks and outside the reefs. Considered a fine food fish by the colored people. The only specimen preserved was identified by Mr. Garman as belonging to this species.

TELEOSTEI.

ANGUILLIDAE.

Anguilla chrisypa Raf. Eel.

A. bostoniensis (Le Sueur) Ayres. Goode, '**76**[a], p. 71.

Distribution. — Atlantic coast (ascending rivers); West Indies.

Said to be common in ditches in Devonshire Marshes. The specimens, seven in number, were all obtained in mud-holes near the mangrove swamp at Hungry Bay. I found four there in April, 1903, and three in July, 1903. The largest specimen was about 4 inches in length. The only water connection of this swamp was directly with the ocean, and as no eels have ever been taken off the shores of Bermuda, it puzzles me to know how such young eels got into the mangrove swamp. The Devonshire Marshes, so far as I could learn, have no connection with the ocean; the water there is only slightly brackish.

MURAENIDAE.

Lycodontis moringa (Cuv.) Spotted Moray.

Gymnothorax moringa (Cuv.) Goode. Goode, '**76**[a], p. 72.

Distribution. — West Indies; North coast of South America; St. Helena.

This species with the larger *L. funebris* (Ranzani) was quite common about all the reefs, particularly off the south shore, where many are taken by fishing from the rocks. The specimen before me was taken during the "Challenger Bank Expedition" — a three-days trip provided by Captain Meyer, of St. George's, for the members of the Biological Station about the first of August, 1903. The flesh is eaten by the negroes, who say that it is sugary-sweet, and very tender; I heard nothing of its being considered poisonous.

L. sanctae-helenae (Günther).

Distribution. — Tropical Atlantic; St. Helena.

A single example taken in 1904; compared with the preceding this species is rather rare.

OPHICHTHYIDAE.

Sphagebranchus anguiformis (Peters).

Distribution. — West Indian region.

A single example of this rare species was dredged in shallow water by Professor Mark on Aug. 6., 1904, at Station No. 468. It is without spots and is $5\frac{1}{2}$ inches long. The head is contained 18 times in the length of the body. A second specimen of this species, which I may mention in this connection, was dredged by Messrs. G. M. Allen, Owen Bryant and myself while on our Northern Bahama Expedition in July, 1904. It is far larger, being of the same proportions and $12\frac{1}{2}$ inches long. It was dredged in 14 fms. in Whale Cay Channel off the Island of Abaco, Bahamas.

ALBULIDAE.

Albula vulpes (Linné). Bone fish.

Distribution. — Tropical seas, almost universally distributed.

D. 15; A. 8.

The species is rare at Bermuda; I have examined only a single specimen taken there. (M. C. Z. No. 18,088.)

CLUPEIDAE.

Sardinella anchovia Cuv. & Val. Anchovy.

Goode, '**76**[a], p. 69.

Distribution. — West Indies, N. Coast of South America.

D. 16; A. 16.

Large schools of this clupeoid were seined regularly in Hamilton Harbor and Flatts Inlet for bait. They appeared to run up into shoal water at about sunrise or sundown.

S. macrophthalma (Ranzani). Pilchard.

Harengula macrophthalma (Ranzani). Goode, '**76**[a], p. 69.

Distribution. — West Indies, coast of Brazil.

D. 17; A. 18. Sc. 40; 12.

We took only two specimens of this species. Mr. H. B. Bigelow and myself each took one about 11 o'clock one very warm evening in August in Flatts Inlet on a hook baited with strips of *Bathystoma*. A dark lantern turned toward the water showed a considerable number of what appeared to be the same species swimming about; no more were seen afterward. They are said to be rather common in winter.

Opisthonema oglinum (Le Sueur). Herring.

O. thrissa (L.) Goode, '**76**[a], p. 69.

Distribution. — West Indies, common on coasts of Florida, Georgia, and the Carolinas, occasionally much farther northward.

D. 19; A. 24.

I have about 100 specimens of this common tropical herring, varying in size from one to five inches. They appeared erratically in great schools.

ENGRAULIDAE.

Stolephorus choerostomus (GOODE). Hog-mouth Fry.

Engraulis choerostomus Goode. Goode, '**74**, p. 380; and '**76**[a], p. 70. Jordan & Evermann, '**96–00**, vol. 1 (1896), p. 444.

Distribution. — Bermuda and Porto Rico.

D. 13 or 14; A. 23.

This species was not at all common during July, but in August immense quantities were seined for bait in Bailey's Bay and Flatts Inlet.

SYNODONTIDAE.

Synodus saurus (LINNÉ). Snake fish.

S. lacerta (Valenciennes) Goode. Goode, '**76**[a], p. 68. Jordan & Evermann, '**96–00**, vol. 1 (1896), p. 537.

Distribution. — Atlantic coast of Southern Europe; Bermuda.

D. 12; A. 12.

One of the two specimens taken jumped into a rowboat at Flatts Inlet; they frequently rise three feet from the water in the upward dash after their prey. The second specimen was taken from the fish pot of a Portuguese at Cooper's Island by Messrs. Nichols and Bryant.

We had many opportunities to watch their habits as they lay on the white shell and coral sand in the Flatts Inlet. They changed color remarkably and mimicked their surroundings very closely indeed. They would wait until their food, usually a small fish, was directly over them, and then rise with great speed, and seize it from below.

ESOCIDAE.

Tylosurus raphidoma (RANZANI).

Distribution. — West Indies; coasts of Florida and Brazil.

D. 23; A. 22.

This species has not, I believe, been found at Bermuda before. One small specimen ($4\frac{1}{2}''$ lg.) was taken with a fine seine in Flatts Inlet. It showed none of the silvery coloring of the adults, but was covered with stellate chromatophores.

T. acus (LACÉPÈDE). Hound.

Distribution. — West Indies, occasionally northward and in the Mediterranean Sea.

D. 23; A. 21.

This species was present in great numbers in most of the inlets and bays about the islands. We obtained a number of specimens on hooks baited with *Sardinella* or *Stolephorus*. These fishes play havoc with the useful bait fishes, killing numbers which they do not eat. They all contained parasitic worms in the trunk musculature.

HEMIRAMPHIDAE.

Hyporhamphus unifasciatus (Ranzani). Needle fish, Gar fish.

Distribution. — Southern Florida, Panama, and Brazil.

D. 12; A. 15.

Specimens were taken with seine at low tide in the Flatts Inlet. They were quite common, but did not appear as regularly or in as large numbers as did *Tylosurus acus*.

Hemiramphus brasiliensis (Linné).

H. pleii (Cuv. & Val.) Goode. Goode, **'76**[a], p. 64.

Distribution. — The West Indian region.

D. 14; A. 12.

One badly damaged specimen, apparently of this species, is in the collection of the M. C. Z. No. 8,774, taken by Captain Hamilton at Bermuda about 1870.

EXOCOETIDAE.

Exonautes esiliens (Müller). Flying fish.

Exocoetus exiliens Gmelin. Goode, **'76**[a], p. 64.

Distribution. — Pelagic.

D. 12–13; A. 12; P. 18; V. 6; C. 21.

One young specimen of what appears to be this species was taken from *Sargassum* off the Challenger Banks and thirteen young examples were taken in the tow net, July 7, at 9 p. m., wind east, in Flatts Inlet. No adult flying-fishes were seen close to shore at any time, and only very few inside the outer reefs. Hundreds of flying fishes, however, were seen from the steamer from forty to sixty miles off shore.

FISTULARIIDAE.

Fistularia tabacaria Linné.

Goode, **'76**[a], p. 27.
Fistularia serrata Goode, **'76**[a], p. 75.

Distribution. — West Indies, straying northward.

D. 14; A. 13.

One specimen of this curious species was taken by Mr. L. Mowbray off St. George's and was kindly obtained from him by Prof. E. L. Mark for examination.

SYNGNATHIDAE.

Siphostoma jonesi (Günther).

Jordan & Evermann, '**96–00**, vol. 1 (1896), p. 768.
Syngnathus jonesi Günther, '**74**, p. 455. Goode, '**76**[1], p. 27.

Distribution. — Bermuda and Porto Rico.

Mr. O. Bryant obtained a single specimen of this species under a rock at Hungry Bay; and a second specimen has recently been handed me by Professor Mark; it was taken during July, 1904.

S. pelagicum (Osbeck).

Syngnathus pelagicus Osbeck. Goode, **76**[1], p. 27.

Distribution. — Tropical Atlantic and Mediterranean.

About a dozen specimens were obtained in *Sargassum* and by the dredge in from 6–12 fm. Several very large specimens were taken during July, 1904.

S. mackayi Swain & Meek.

Distribution. — S. Florida to Yucatan.

One small specimen was taken from the dredge in Castle Harbor. This is the first time the species has been reported from Bermuda.

S. dendriticum, sp. nov.

(Plate 1.)

Type, (M. C. Z. No. 29,057) a single specimen dredged in about 7 fms. off Ireland Island, Bermudas, July, 1904.

Rings 14 + 39. Dorsal 16, just over vent on rings 1–4.

Snout about twice in distance to base of pectoral. Tail longer than body. Anal fin vestigial; composed of two rays on ring 2. Color brown with irregular blotches and darker marblings. A number of peculiar filamentous appendages; many of these have probably been torn off, as this specimen was taken in the dredge with a considerable mass of broken *Oculina*, etc. The largest pair of these appendages is situated just above and behind the orbits. The next largest pair is on the nape, just anterior to the branchial aperture. Pairs of filaments are situated irregularly along the dorsal and ventral surfaces. On the segments of the trunk rings are peculiar radiating striae; and a raised boss marks the centre of each segment. On the tail rings the bosses are very conspicuous and the ornamental striae less so.

HIPPOCAMPIDAE.

Hippocampus sp. Sea Horse.

One exceedingly small specimen taken in the tow-net off Flatts Inlet one night during July. I have been unable to determine the species. Sea-horses are well known to the natives, and are said to be common at certains seasons.

ATHERINIDAE.

Menidia notata (Mitchill).

Distribution. — Coast of United States southward to the Carolinas.

D. 6 + 9 ; A. 1. 23.

There is one specimen of this species in the collection of the M. C. Z. (No. 18,246); so far as I can ascertain no other specimen has ever been taken.

M. menidia (Linné). Blue Fry.

Distribution. — Atlantic coast of United States, the Carolinas southward.

D. 4 + 9 ; A. 1 + 22.

This species was exceedingly common in Flatts Inlet. Thousands were seined daily by the natives for bait.

MUGILIDAE.

Mugil brasiliensis Agassiz. Mullet.

M. liza Cuv. & Val. Goode, **'76**[a], p. 63.

Distribution. — West Indies ; Atlantic coast of South America.

D. 5 + 8 ; A. 3 + 8.

Specimens were frequently taken from the seine in Flatts Inlet; the species is generally common.

M. curema Cuv. & Val.

Distribution. — Both coasts of the Americas.

D. 5 + 5 ; A. 3 + 9.

I obtained a large number of specimens of this species in March and April, 1903. at Hungry Bay. During the summer, however, only one specimen was taken ; this was from *Sargassum* floating off Ireland Island. The species has not been taken before at Bermuda.

SPHYRAENIDAE.

Sphyraena sphyraena (Linné.)

S. spet (Haüy) Goode, **'76**[a], p. 61.
Jordan & Evermann, **'96–00**, vol. 1 (1896), p. 826.

Distribution. — Southern coast of Europe to Bermuda.

D. 6 + 9 ; A. 1 + 9.

This European species is not uncommon about Bermuda. I have a single specimen about 10 inches long taken in the seine near Gibbet Island and another, considerably smaller, taken by the members of the Biological Station during the summer of 1904.

HOLOCENTRIDAE.

Holocentrus ascensionis (Osbeck). Squirrel.

Holocentrum sogo Bloch. Goode, '76a, p. 49.

Distribution. — Florida and Cuba to St. Helena.

D. 11 + 15 ; A. 6 + 10.

This species is very common in sheltered nooks about the rocky shores and reefs. It is nocturnal and great numbers were sometimes taken in a few hours at night in the fish pots.

H. puncticulatus, sp. nov.

(Plate 2.)

D. 11 + 13 ; A. 4 + 8 ; ll. 45 ; ltr. 3 + 8.

Near *H. siccifer* Cope, but differing in the number of rays in the anal fin, in the shape of the dorsal fins, and in color.

Head with spines $2\frac{1}{2}$, depth $2\frac{3}{4}$. Spinous dorsal rather long and elevated anteriorly ; soft dorsal not as high as spinous portion. Second anal spine and first anal soft ray about the same length and almost reaching the base of the caudal. There is one strong spine on the preopercular bone and one on the opercular. The posterior and ventral edges of both these bones are strongly serrate. The interorbital keels are rather weak, and each divides posteriorly into nine, spreading out in a fan-like manner.

The color in life is bright rosy red with nine lateral series of very fine black and dark brown dots ; growing fainter and fewer ventrally. A large black spot appears on the membrane of the first three dorsal spines, and also on the spines themselves. The rest of the fins are rosy white, except for a few extremely faint dusky patches on the posterior part of the first dorsal.

This species is represented by the single type specimen (M. C. Z. No. 29,054), Flatts Inlet, Bermuda Is. Taken in a fish trap in about 10 ft. of water. The species is rather common, and other specimens were seen.

MULLIDAE.

Upeneus maculatus (Bloch). Goat fish.

Hypeneus maculatus (Bloch) Cuv. Goode, '76a, p. 49.

Distribution. — West Indian region.

D. 8 + 8 ; A. 2 + 6.

Probably common in rather deep water outside the reef. One specimen was taken in a fish pot off Hungry Bay by a fisherman, who said that the species was not uncommon, and another from the stomach of a large grouper (*Epinephelus striatus*).

CARANGIDAE.

Decapterus punctatus (Agassiz). Robin.

Goode, '76, p. 46.

Distribution. — Mass. to Brazil.

D. 3 + 30 (31); D. 3 + 25. Sc. 40 about.

I have four specimens, two taken by Dr. A. S. Bickmore (M. C. Z. No. 17,054), and two taken in Harrington Sound in July, 1903. This species is common at times, but it is at other times quite impossible to find a single specimen. They take bait best at night in moderately deep water.

Seriola zonata (Mitchill). Crevalle.

Goode, '76[1], p. 75.

Distribution. — Massachusetts to the Carolinas.

D. 8 + 38; A. 3 + 21.

One specimen taken on the Challenger Banks. I saw quite a number of these brought in by the Hamilton fishermen. They were usually taken far off shore.

Trachurops crumenophthalmus (Bloch). Goggle-eye.

Goode, '76[1] p. 47.

Distribution. — Coast of Atlantic Ocean (except Europe). Pacific off Central America and Mexico.

D. 8 + 26; A. 3 + 22. Sc. 36.

One specimen about two inches long was taken from *Sargassum* off the Challenger Banks and turned over to me by Professor Mark. The species was very rare at Bermuda all summer. A slightly smaller specimen was taken during July, 1904.

Caranx ruber (Bloch).

Distribution. — West Indies.

D. 8 + 27; A. 2 + 23. Sc. 30.

One specimen taken in the tide rush at mouth of Harrington Sound on hook baited with *Stolephorus*. A second specimen (M. C. Z. 17,360) was taken at Bermuda in 1864 by Capt. Hamilton. This specimen has 31 scutes on the caudal pedicel.

C. hippos (Linné).

Distribution. — Tropical seas.

D. 8 + 21; A. 2 + 17. Sc. 30.

One specimen taken on hook and line in Flatts Inlet in about four feet of water and two specimens from Hamilton (M. C. Z. No. 28,989) are the only representatives of this widely distributed species which I have had an opportunity to examine from Bermuda.

C. crysos (Mitchill). Jack.

Goode, 76[1], p. 75.
Paratractus pisquetus (C. & V.) Gill. Goode, 76[1], p. 47.

Distribution. — Massachusetts to Brazil.

D. 8 + 25; A. 2 + 21. Sc. 45.

I have examined four specimens of this species from Bermuda; three were taken in the summer of 1903 at Flatts Inlet, the other at Hamilton about 1870 (M. C. Z. No. 17338). A number of these fishes were almost always to be found lying in wait for fry carried out of Harrington Sound by the tide. They took bait voraciously and afforded considerable sport for their size. We took none over 9 inches in length. The name Jack is applied to several species.

NOMEIDAE.

Nomeus gronovii (Gmelin).

Jordan & Evermann, '96-00, vol. 1 (1896), p. 949.

Distribution. — Tropical Atlantic.

D. 11 + 26; A. 3 + 26.

This species appears to be rather common in Castle Harbor, where the only specimens seen were taken. They usually swim about among the tentacles of the Portuguese-man-o-war, but the only specimen I caught was swimming lazily along near the surface of the water; there were, however, plenty of *Physaliae* near by.

CORYPHAENIDAE.

Coryphaena equisetis (Linné). Dolphin.

Distribution. — Open Atlantic, most common in the tropics.

D. 52; A. 25.

A single specimen taken off Bermuda during the summer of 1904. It was said to be very common at all times at some distance off shore.

CHEILODIPTERIDAE.

Apogon binotata (Poey).

Distribution. — Florida, West Indies, and Brazil.

D. 7 + 8; A. 2 + 8.

A single specimen of this species was taken in Castle Harbor, it appears to be rare. Several natives to whom I showed the specimen declared that they had never seen it before. I compared it with Poey's type from Cuba (M. C. Z. No. 8,750) and could find no difference between them.

A. maculata (Poey).

Distribution. — Cuba.

D. 4 + 10; A. 2 + 7; ll. 27, ltr. 2 + 10.

I have five specimens of this handsome species. Three of these were taken in Flatts Inlet; I took one in July, 1903, and Mr. Nichols two in August. The remaining two came from some floating *Sargassum*; one on the Challenger Banks, the other near the main island; both specimens are very small. I was told that the species became very common in Flatts Inlet about the latter half of August.

SERRANIDAE.

Bodianus fulvus (Linné). Nigger fish..

Jordan & Evermann, '96–00, vol. 1 (1896), p. 1144.

Distribution.—West Indies.

This species appears to be very generally distributed over the reefs, and moderately common everywhere.

Epinephelus striatus (Bloch). Grouper, Hamlet.

Goode, '76[a], p. 57.

Distribution. — West Indies to Brazil.

D. 9 + 17; A. 3 + 8.

The most important food fish taken near Bermuda. My specimens are small ones taken in fish pots near Flatts Inlet. It attains a weight of 40 pounds.

E. maculosus (Cuv. & Val.). Hind.

Jordan & Evermann, '96–00, vol. 1 (1896), p. 1158.
E. gutattus (Gmelin) Goode. Goode, '76[a] p. 58.

Distribution. — The West Indies generally.

D. 9 + 16; A. 3 + 8.

This species was very common everywhere about the reefs. We took specimens by the hook up to 15 or 16 inches in length near North Rock, where they were especially common. Their power of changing color is highly developed; for they change from almost uniform ruddy to flaming red spotted regularly with deep brown or black.

E. morio (Cuv. & Val.). Red Hamlet.

Distribution. — Southern Atlantic coast of North America southward to Brazil.

D. 9 + 16; A. 3 + 9.

This species was generally taken with *E. striatus*, but was far more rare than that species. It is said to be growing more common year by year.

Mycteroperca venenosa apua (Bloch). Rock-fish.

Trisotropis undulosus (Cuv.) Gill. Goode, '76[a], p. 55.

Distribution. — West Indies, Florida Keys to Brazil.

Grows to a great size and is one of the most important of the common food fishes.

Hypoplectrus puella Cuv. & Val. Mutton Hamlet.

Goode, '76[1], p. 60.

Distribution. — West Indies.

D. 10 + 14; A. 3 + 7.

Not uncommon about rocky shores with very steep banks; but locally distributed. Six specimens were taken in fish pots in Harrington Sound near the bridge and off the dock of the Hotel Frascati.

Paranthias furcifer (Cuv. & Val.). Barber.

Distribution. — Both coasts of Tropical America.

D. 9 + 18; A. 3 + 9.

This species has not been previously recorded from Bermuda. Mr. J. T. Nichols took three specimens, each about 1 foot long, off the south shore near Hungry Bay with hook and line. Two were also among the collection made in July, 1904. The color of all was a dull uniform rose pink.

LUTIANIDAE.

Neomaenis griseus (Linné). Gray snapper.

Lutjanus caxis (Schn.) Poey. Goode, '76[1], p. 54.

Distribution. — West Indies, South Atlantic coast of United States to Brazil.

D. 10 + 14; A. 3 + 8; ll. 51; ltr. 7 + 13.

One of the most common Bermudian fishes; large schools could be seen swimming about in Harrington Sound or Flatts Inlet at any time. About 50 of them spent most of their time under our boat at her moorings, never seemed to be more than a few yards from this location. They are shy and extremely difficult to take. The specimens before me are from Harrington Sound. They appear less shy in Hamilton Harbor, where many are taken on hooks and in fish pots for bait.

N. apodus (Walbaum). Schoolmaster.

Distribution.—West Indies; Florida to Brazil.

D. 10 + 14; A. 3 + 8.

Several specimens taken from both Hungry Bay and Harrington Sound. The young were common in many small coves along this shore, and large specimens are often taken about the outer reefs.

N. vivanus (Cuv. & Val.). Silk snapper.

Distribution. — West Indies.

D. 10 + 14; A. 3 + 8.

A very common species in the deeper water about the outer reefs and in the middle of Harrington Sound. I have several specimens taken with a fish pot in the steamboat channel about opposite Bailey's Bay. This species takes bait well, especially at night, and affords fair sport.

N. hastingsi Bean. Spot snapper.

Bean, '98, p. 45.

Distribution. — The Bermudas.

D. 10 + 14; A. 3 + 8.

One specimen of this species was turned over to me by Prof. E. L. Mark; it was taken on the Challenger Banks. Dr. Bean states that this is the "silk snapper" of the native fishermen; but so far as I could ascertain from numerous inquiries, that name is only used for *N. vivanus* (C. & V.).

Ocyurus chrysurus (Bloch). Yellow tail.

Goode, '76[a], p. 55.

Distribution. — West Indies to Brazil.

D. 10 + 13; A. 3 + 9; ll. 66; ltr. 7 + 16.

This species was very common in Harrington Sound, where large numbers were sometimes taken using "scuttle" (*Octopus rugosus*) for bait. My specimens are from fish pots in Flatts Inlet and Harrington Sound. The species attains a weight of 5 lbs.

HAEMULIDAE.

Haemulon macrostomum Günther. Sow grunt.

Distribution.—West Indies generally.

D. 12 + 16; S. 3 + 8.

This species was frequently brought into Hamilton by the fishermen, who took it in rather deep water near the outer reefs, usually in company with *Haemulon album.*

H. carbonarium Poey. Bull grunt.

Jordan & Evermann, '96-00, vol. 2 (1898), p. 1300.

Distribution. — West Indies.

D. 12 + 16; A. 3 + 8.

This fish was not at all uncommon off the South shore; it was rarely taken anywhere else. We have several specimens from about one mile south of the mouth of Hungry Bay.

H. sciurus (Shaw). Striped grunt.

Distribution. — West Indies generally.

This fish was taken occasionally in fish pots off the South shore and in Hamilton Harbor. It did not appear to be nearly as common as *H. flavolineatum.* There are two specimens (M. C. Z. No. 10,555) which were taken in 1862 by Dr. Bickmore.

H. flavolineatum (Desmarest). Yellow grunt.

Jordan & Evermann, '96–00, vol. 2 (1898), p. 1306.

Distribution. — West Indies.

This species is very common everywhere about Bermuda. There are thirty-four specimens in the Museum which were taken by Dr. A. S. Bickmore in September, 1862 (M. C. Z. Nos. 10,526, 10,541). It does not usually grow to a size suitable for food. A large number were taken during August, 1903, in Harrington Sound.

Orthopristis chrysopterus (Linné). Sailor's choice.

Distribution. — Atlantic and Gulf coasts of the United States.

D. 13 + 16; A. 3 + 12.

This species was quite common in Hamilton Harbor, though I never saw a single example elsewhere in the Bermudas.

Bathystoma striatum (Linné).

Jordan & Evermann, '96–00, vol. 2 (1898), p. 1310.

Distribution. — Bermudas to South America.

D. 13 + 13; A. + 37.

Common, particularly in Flatts Inlet, where it may be taken any day usually associated with very large numbers of *B. rimator.* There are twenty specimens (M. C. Z. No. 10,602) which were taken by Dr. Bickmore in 1862.

B. rimator (Jordan & Swain). White grunt.

Distribution. — East coast of United States and West Indies.

D. 13 + 15; A. 3 + 8.

An excessively common species in Flatts Inlet, less so elsewhere. I have specimens taken in a fish trap in Harrington Sound and Flatts Inlet; any number could have been collected.

SPARIDAE.

Calamus calamus (Cuv. & Val.). Porgy.

C. megacephalus (Swainson) Poey. Goode, '76[a], p. 51.
C. orbitarius Poey. Goode, 76[a], p. 51.

Distribution. — West Indies and Florida.

D. 12 + 12; A. 3 + 10.

The fishermen recognize two "Porgies": the "Goat head," and the "Sheep head." I think, however, that both species are referable to *C. calamus*, for they did not seem to be very certain as to just what constituted a "Goat head" or "Sheep head" porgy.

Diplodus sargus (Linné). Bream.

Jordan & Evermann, '96-00, vol. 2 (1898), 1363.
Sargus variegatus (Lacépède), Goode. Goode, '76[a], p. 52.

Distribution. — Coast of Southern Europe, westward to Bermuda.

D. 12 + 13 (14); A. 3 + 13 (14).

One of the commonest shoal water species. It was strangely confused with *Kyphosus sectatrix* by Goode.

GERRIDAE.

Eucinostomus gula (Cuv. & Val.). Shad.

Goode, '76[a], p. 39.

Distribution. — New York (rarely) to Brazil.

D. 9 + 10; A. 3 + 8.

Common, generally associated in small schools with the young of *Neomaenis griseus* and *Mugil brasiliensis*.

KYPHOSIDAE.

Kyphosus sectatrix (Linné). Chub.

Pimelepterus boscii (Lacépède). Goode, '76 , p. 52.

Distribution. — Pelagic in North Atlantic; West Indies.

D. 11 + 12; A. 3 + 11.

This species may be called an irregular, though usually very common, visitor at Bermuda.

POMACENTRIDAE.

Abudefduf saxatilis (Linné). Cow pilot. Sergeant major.

Glyphidodon saxatilis (Linné) Cuvier. Goode, '76[a], p. 38.

Distribution. — Both coasts of Tropical America.

D. 8 + 13; A. 2 + 12; ll. 28; ltr. 11 + 5.

I have about twenty specimens of this species varying in length from a half inch to four inches, the latter being a large one for the shores of Bermuda. I saw a very large specimen in a rock pool at North Rock. Native fishermen state that the species attains a weight of one and one half pounds in the deep water off the Rock. It is very common everywhere.

Furcaria cyanea Poey.

Distribution. — Cuba.

D. 12 + 12; S. 2 + 12.

A single specimen from Bermuda taken in 1864 by Captain Hamilton (M. C. Z. No. 14,801). I can find no other record for the occurrence of this species except off Cuba.

Microspathodon chrysurus (Cuv. & Val.).

Distribution. — West Indies.

Two very small specimens from *Sargassum* off Ireland Island. The species does not appear in previous lists, so far as I am aware.

Eupomacentrus leucostictus (Müller & Troschel). Cock-eye pilot.

Distribution. — West Indies; Florida.

D. 12 + 15 ; A. 2 + 13.

Although with considerable hesitation, I refer to this species a number of Pomacentroids which were taken in various localities, about the Islands. The genus is in a very confused condition, and I have no desire to describe these specimens as new until a more extensive examination of existing material can be made.

E. fuscus (Cuv. & Val.). Brown cock-eye pilot.

Verrill, **:01**, p. 56.

Distribution. — Florida to Brazil; West Indies.

Specimens which may be this species are very common in many localities especially at the head of Hungry Bay, both among the loose rocks of the Spit and among the roots of the mangroves.

LABRIDAE.

Lachnolaimus maximus (Walbaum). Hog fish.

Jordan & Evermann, **'96-00**, vol. 2 (1898), p. 1579.
L. falatus (L.). Goode, **'76**[a], p. 36.

Distribution. — West Indies.

D. 14 + 11; A. 3 + 10.

An important and common food fish, growing to the size of about twenty pounds.

Iridio radiatus (Linné). Lady fish. Blue fish.

Jordan & Evermann, **'96–00**, vol. 2 (1898), p. 1590.
Choerojulis radiatus (L.) Goode. Goode, **'76**[a], p. 35.

Distribution. — West Indies; Florida to Brazil: St. Paul's rocks.

Not uncommon a short distance off the South shore.

I. cyanocephalus (Bloch). Blue head.

Distribution. — West Indies to Brazil.

Rather rare; the few which we have were taken on the reef off the south shore. This is the most northerly record for the species.

I. garnoti (Cuv. & Val.).

Distribution. — West Indies.

One small specimen obtained in Castle Harbor. The species has not been recorded from Bermuda before.

I. bivittatus (Bloch). Slippery Dick.

Platyglossus bivittatus Bloch. Goode, **'76**[1], p. 75. Garman, **:00**, p. 510.

Distribution. — West Indies; Carolinas to Brazil.

D. 9 + 11; A. 3 + 12.

Very common everywhere.

Chlorichthys nitidissimus (Goode). Slippery Dick.

Jordan & Evermann, **'96-00**, vol. 2 (1898), p. 1608.

Distribution. — The Bermudas.

Rather common about the outer reefs.

SCARIDAE.

Sparisoma abildgaardi (Bloch).

Distribution. — West Indies to Brazil.

D. 9 + 10; A. 2 + 9.

This and the three following species are all called Parrot fishes. I have a single specimen of this species taken in a fish pot off the south shore. It does not appear to have been recorded from so far north before.

S. viride (Bonnaterre).

Distribution. — West Indies.

D. 9 + 10; A. 2 + 9.

A single specimen, which was taken with the preceding species, is the only one we obtained. The natives consider it very rare.

Scarus croicensis (Bloch).

Pseudoscarus sanctae-crucis Günther. Goode, **'76**[1], p. 75.

Distribution. — West Indies generally.

D. 9 + 10; A. 2 + 9.

Not uncommon in Castle Harbor and occasional in Flatts Inlet. There are several specimens taken from both localities in the collection made in the summer of 1903.

S. caeruleus (Bloch).

Pseudoscarus caeruleus (Bloch) Günther. Goode, **'76**[1], p. 33.
P. psittacus Goode, **'76**, p. 75.

Distribution. — West Indies, on our coast, rare.

D. 9 + 10; A. 2 + 9.

Not uncommon.

CHAETODONTIDAE.

Chaetodon ocellatus (Bloch). Butterfly fish.

Distribution. — Cuba; Gulf Stream northward.

Rather rare about the outer reefs; but said by the fishermen to be increasing rapidly in numbers.

C. capistratus (Linné). Four eyes.

Goode, '76[a], p. 75.

Sarothrodus bimaculatus (Bloch) Poey. Goode, '76[a], p. 43.

Distribution. — West Indies.

D. 12 + 19; A. 3 + 17.

Common in many localities about Hamilton Harbor, Harrington Sound, and Castle Harbor.

Angelichthys ciliaris (Linné). Angel fish.

Holacanthus ciliaris (Linné) Lacépède. Goode, '76[a], p. 43.

Distribution. — West Indies and Florida.

D. 14 + 21; A. 3 + 21.

An important food fish, very common about the reefs and steep shores. For some reason the specimens taken off the north shore are considered much more palatable than those taken off the south shore.

TEUTHIDIDAE.

Teuthis hepatus (Linné). Blue tang.

Acanthurus chirurgus (Bloch.) Schn. Goode, 76[a], p. 42.

Distribution. — The West Indian region.

D. 9 + 24; A. 3 + 22.

A few specimens were obtained, but the species did not appear to be as common as the following, with which it was almost always associated.

T. bahianus (Castelnau). Doctor fish.

Distribution. — West Indies: both coasts of Tropical America.

D. 9 + 25; A. 3 + 23.

Decidedly abundant about the reefs and steep shores. Though the adults did not run up into Flatts Inlet, the young were frequently seen there.

T. helioides, sp. nov. Yellow doctor.

(Plate 3.)

D. 9 + 26; A. 3 + 26.

Most nearly related to *T. chrysosoma* (Bleeker) from the Sea of Kajeli. Form ovate; height of body rather more than one half of total length (caudal fin included). The profile of the snout is slightly concave. There are five

incisors on each side of the upper jaw. The upper lobe of the caudal fin is slightly longer than the lower. The scales of the body are very minute. In life the color was brillant yellow, which has changed in spirits to a dull lustreless yellow. The dorsal, anal, and ventral fins are edged with dusky brown, almost black in some places. There is a diffuse patch of light brown on the operculum.

Type (M. C. Z. No. 29,053) a single specimen five inches long taken near Cooper's Island, in Castle Sound, Bermudas, by Messrs. O. Bryant and J. T. Nichols.

BALISTIDAE.

Balistes carolinensis Gmelin. Turbot.

B. capriscus Gmelin. Goode, '**76**[a], p. 25.

Distribution. — Tropical Atlantic, Mediterranean Sea.

D. 3 + 27; A. 25.

We took several specimens in fish pots in about five fathoms off Flatts Inlet, and I have also one very small one from *Sargassum* of the Challenger Banks given me by Mr. J. T. Nichols. The species grows to considerable size and is frequently eaten, although the flesh is dry and tasteless.

B. vetula Linné. Queen turbot.

Goode, '**76**[a], p. 26.

Distribution. — West Indian region generally.

D. 3 + 29; A. 27.

Not taken by Goode, but nevertheless rather common. A regular visitant at Bermuda, as several are taken every year. The specimen before me was brought into the Biological Station during the summer of 1904.

MONACANTHIDAE.

Alutera scripta (Osbeck).

Goode, '**76**[a], p. 26.

Distribution. — Tropical seas of both hemispheres.

D. 1 + 47; A. 51.

A single specimen of this species was speared at Bermuda during the summer of 1904 and obtained by Professor Mark.

TETRAODONTIDAE.

Spheroides spengleri (Bloch). Puffer.

Chilichthys spengleri (Bloch).
Goode, '**76**[a], p. 22.

Distribution. — Eastern Atlantic.

D. 7; A. 6.

One specimen from Hungry Bay, two inches long, taken by Mr. Nichols and one specimen from the dredge, one inch long, among the reefs off Ireland Island in 8–10 fms. This species did not appear to be at all common and no adults were seen. While collecting invertebrates Mr. Bigelow and I both saw several large "puffers" which appeared to be *S. testudineus*, and I have no doubt that this species will occur in future collections.

SCORPAENIDAE.

Scorpaena agassizii Goode & Bean.

Goode & Bean, '96, p. 247.

Distribution. — West Indian region.

One specimen dredged on the Challenger Bank, by the members of the Biological Station, in forty fathoms.

CEPHALACANTHIDAE.

Cephalacanthus volitans (Linné).

Distribution.—Tropical Atlantic, widely distributed.

D. 2 + 4 + 8; A. 6.

One specimen was taken on the beach at Gibbet Island on June 19, 1903. The species is very rare at Bermuda, and was not known to any of the fishermen that saw the specimen. I learned, however, from Mr. F. Goodwin Gosling, Secy. of the Bermuda Natural History Society, that one specimen had been taken during the spring in Hamilton Harbor.

CALLIONYMIDAE.

Callionymus bermudarum, sp. nov.

D. 3 + 7; A. 4.

Most nearly related to *C. pauciradiatus* Gill; but differing in the number of rays in the second dorsal and in the preopercular spine. Besides giving the radial formula for his specimen (D. 3, 6; A. 3), Gill ('65, p. 144) says: —

"The preopercular spine is armed with three teeth above and terminates behind in an acute point."

A description of the three specimens from Bermuda follows: —

Head (to tip of opercular spine) $3\frac{1}{2}$ times in total length; depth 8 times. Ventral surface of body flat; without a bordering fold of skin; a single lateral line; diameter of eye a little less than length of snout. The maxillary reaches about $\frac{1}{2}$ the distance to the eye. The preopercular spine is armed with two barbs directed forward and situated dorsally; there is also a sharp termination to the spine itself, which is directed straight backward. The gill opening is a very minute slit, also directed backward. In one specimen the first dorsal ray reaches the base of the caudal; each of the other two being successively a little

shorter. In the other two specimens the length of the dorsal is about equal to the distance from the posterior border of the eye to the tip of the snout. The pectoral fins are about as long as the head; the ventrals slightly shorter. The color of these specimens is a milky white, irregularly banded and blotched with light brown. In the largest one (with the filamentous dorsal) the anal fin is rather dark brown and there is a dark spot on the ventral fin and on the middle of the throat, nearly covering it.

Type series, three specimens (M. C. Z. No. 29,055) $1\frac{1}{4}''$, $1''$, $\frac{3}{4}''$, lg. from Bermuda. Taken by the dredge in from 6–8 fms.; Aug. 1903, the largest off Castle Island, the others off Ireland Island.

GOBIIDAE.

Gobius stigmaturus Goode & Bean.

Garman, :00, p. 510.

Distribution. — Bermuda.

D. 4 + 12; A. 12.

One specimen from Hungry Bay was taken from under a stone at low tide in about four inches of water by my brother, Mr. W. W. Barbour, April, 1903; a diligent search in the same and similar localities failed to yield a second specimen.

G. soporator Cuv. & Val. Molly miller.

Goode, '76[1], p. 75.

Distribution. — The West Indian region and Northern South America.

D. 6 + 10; A. 1 + 7.

The forty-eight specimens before me show a decided differentiation into two distinct color phases. One lot, consisting of twenty-six specimens, was taken by me, with the aid of Messrs. Bigelow and Cole, in the rock pools of the south shore near Hungry Bay. All these specimens, except two, which are quite black, are very dark brown. The rest, some twenty or more, were taken by dredging in Castle Harbor and Mangrove Bay, in localities where the bottom was white sand composed of coral, shell, and Foraminifera. All these specimens are light gray, almost white, with a row of dark lateral puncticulations, just visible.

This species is very active and jumps about on the bare rocks washed by the waves and even moves from one tide pool to another over dry land.

BLENNIIDAE.

Labrisomus nuchipinnis (Quoy & Gaim.). Molly miller.

Labrosomus nuchipinnis (Quoy & Gaim.) Poey. Goode, '76[1], p. 28.

Distribution. — West Indies and coast of Southern States.

D. 18 + 12; A. 2 + 17.

I collected four specimens of this species in March, 1903, all of a characteristic mottled brown color. In July, 1903, I took eight more, four of which

showed the same color as those taken in the early spring. The others were gorgeously bright with yellow, red, and orange about the foreparts of their bodies. These were all males, the darker ones being females with eggs almost ready to hatch.

I had an opportunity to watch a pair of these fishes getting ready to lay. The female would move swiftly about in the sand under a protecting rock, thus scooping out a hollow place in which she probably deposited her eggs. In a few days the female, looking thinner, lay quite still near the hollow in the sand, where I presume the eggs had been laid; the male was swimming nervously about as if to drive away intruders. Up to the time I left, more than a month after the probable laying of the eggs, the male, with the same gaudy color, was still swimming about; the female was gone, and I presume the young had been hatched and had long since departed.

Salariichthys textilis (Quoy & Gaim.). Molly miller.

Salarias textilis, Quoy & Gaim. Goode, '76[a], p. 29.

Distribution. — Bermudas to Northern South America.

Very common in tide pools about the shores and at North Rock.

BROTULIDAE.

Brosmophysis verrillii Garman.

Garman, :00, p. 511.

Distribution. — Bermuda.

D. 71; A. 52; ll. 98; ltr. 25.

Several specimens of this little known Brotuloid were taken by Mr. H. B. Bigelow and myself from the rock pools near Flatts Inlet and Gibbet Island. A diligent search at Bailey's Bay, the type locality, and in many other likely places failed to reveal a single specimen.

PLEURONECTIDAE.

Platophrys lunatus (Linné). Plate fish.

Distribution. — West Indies generally.

Apparently the only flat fish which is common about Bermuda. Several were taken during my stay in the summer. The only specimen which I had an opportunity to observe carefully was one loaned to Professor Mark by Mr. L. Mowbray of St. George's.

ANTENNARIIDAE.

Pterophryne gibba (Mitchill). Mouse fish.

Distribution. — West Indies generally.

D. 3 + 12; A. 7.

Very common in the *Sargassum*. I have about sixty specimens, a few of which were taken from the dredge off Ireland Island.

P. ranina Tiles.

Distribution. — Fields of sea weed in the Tropical Atlantic, Richardson.

A single large pediculate was obtained from a colored fisherman and handed to me by Professor Mark. It is evidently Cuvier's *Chironectis laevigatus* and also agrees remarkably well with Richardson's (**'44–48**, p. 15, pl. 9, Fig. 354), *Chironectis pictus* var. *vittatus*.

Antennarius stellifer, sp. nov.

(Plate 4.)

D. 3 + 12; A. 7; V. 5; P. 10; C. 9.

Closely related to *A. nuttingii* Garman; but differing conspicuously in coloration, size, and form of bait.

In form this species is short and extremely bulky anteriorly. The caudal peduncle is short and compressed. The head is as wide as high; with a rather deep, scaleless concavity behind the second dorsal ray. The mouth is very wide, almost vertical, and the eye is small. The first dorsal ray is extremely long and slender, a little more than $2\frac{1}{2}$ times the length of the second dorsal ray. On the posterior surface of the second dorsal ray there is a peculiar fringe of elongate scales, a tuft of similar scales being situated on each side of the naked occipital depression. The base of the first dorsal ray is a prominent movable pedicel. The second dorsal ray is quite free, while the third is connected with the dorsum by the skin. The soft dorsal is composed of two regions; the anterior five rays are of equal size and their tips do not extend beyond the connecting membrane. The condition in the posterior part of the fin is very different; the rays do project beyond the membrane, and from the sixth to eighth ray the height of the fin increases regularly, while from the ninth to twelfth the decrease is as regular, so that the posterior portion is more or less fan-shaped. The bait on the tip of the first dorsal ray is a tiny sphere, from which spring numerous delicate filaments.

The color of this species, described from the alcoholic specimen, is as follows: — The entire body is very dark brown, almost black with areas of deep velvety black, which are sometimes surrounded in a zone of lighter brown. The bait, posterior surface of second dorsal ray and under surface of the pectoral and ventral fins is dirty white. There is on each side of the body an irregularly stellate figure of white composed of a central patch and radiating spots. A white saddle is situated on the caudal peduncle.

Only one specimen known, the type (M. C. Z., No. 29,056), obtained in Castle Harbor by Mr. L. Mowbray of St. George's, and procured from him by Professor Mark.

A. scaber (Cuv.)

Distribution. — West Indian waters.

A single specimen from Bermuda was obtained in exchange from the Boston Society of Natural History. It had been in the collection for some time.

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EXPLANATION OF PLATES.

PLATE 1.

Siphostoma dendriticum, sp. nov. (p. 115).
Four (4) times natural size

PLATE 2.

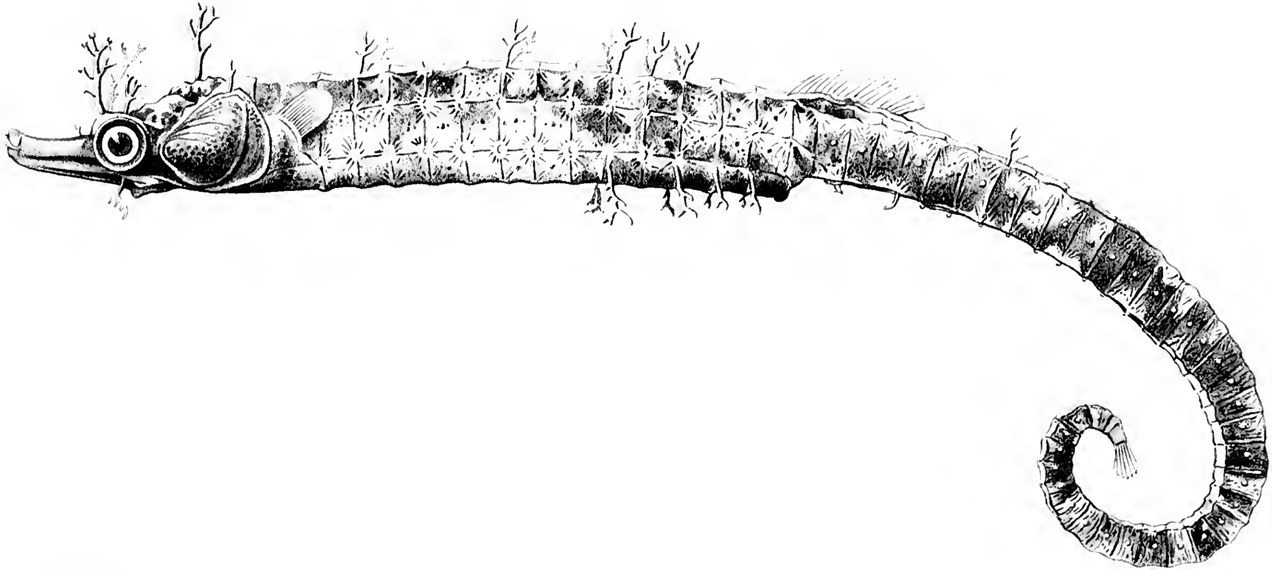
Holocentrus puncticulatus, sp. nov. (p. 117),
Twice natural size.

PLATE 3.

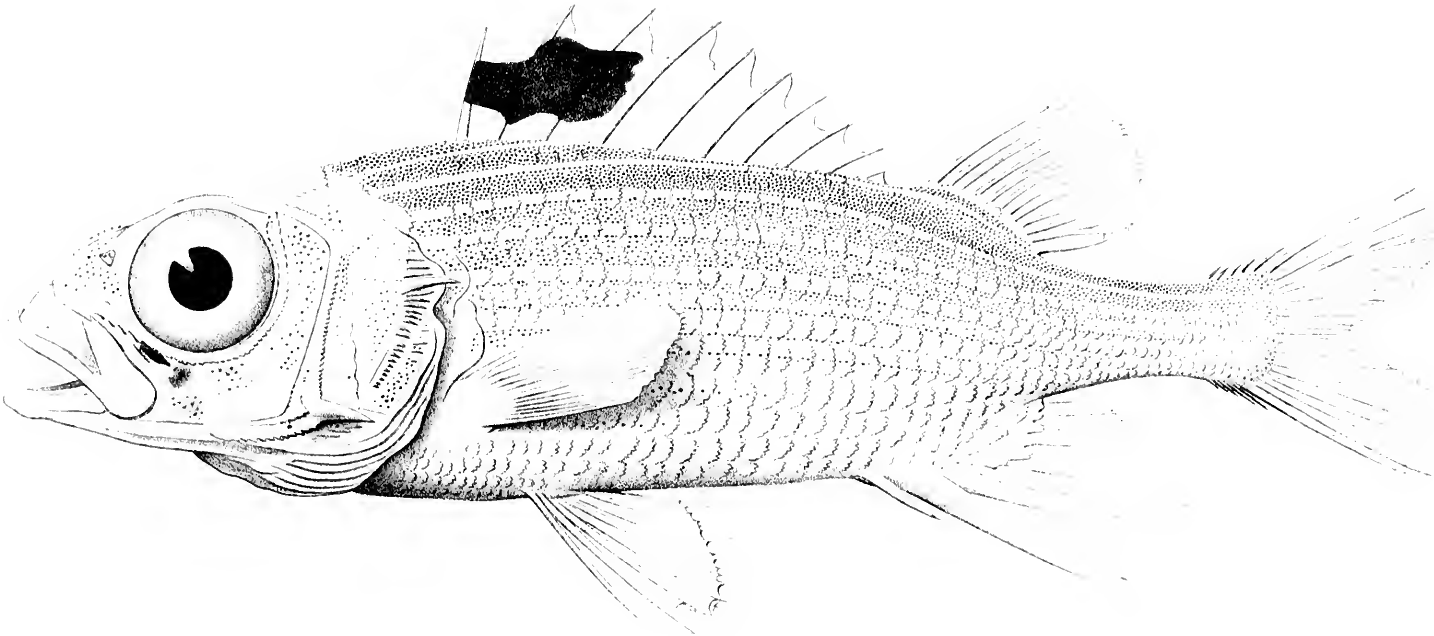
Teuthis helioides, sp. nov. (p. 127).
Natural size.

PLATE 4.

Antennarius stellifer, sp. nov. (p. 132).
Very slightly enlarged.



H. N. Fischer del.



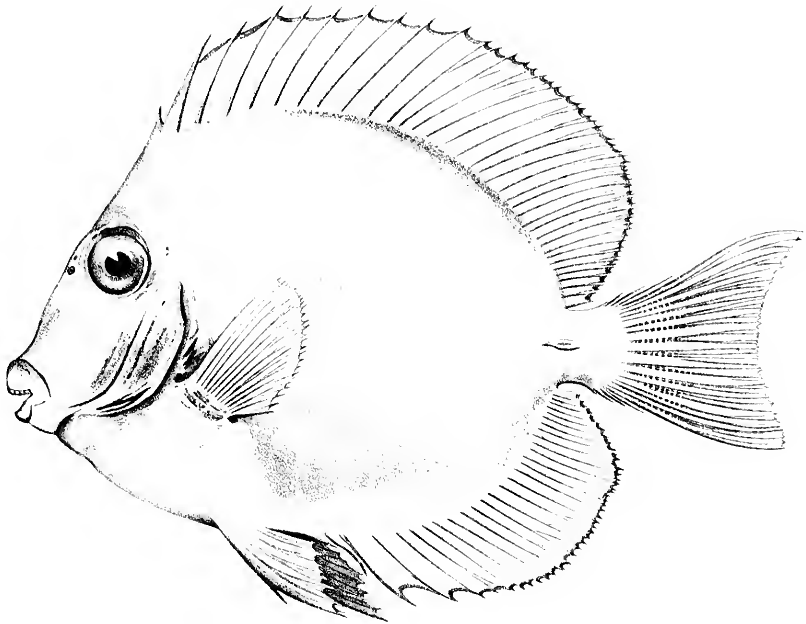
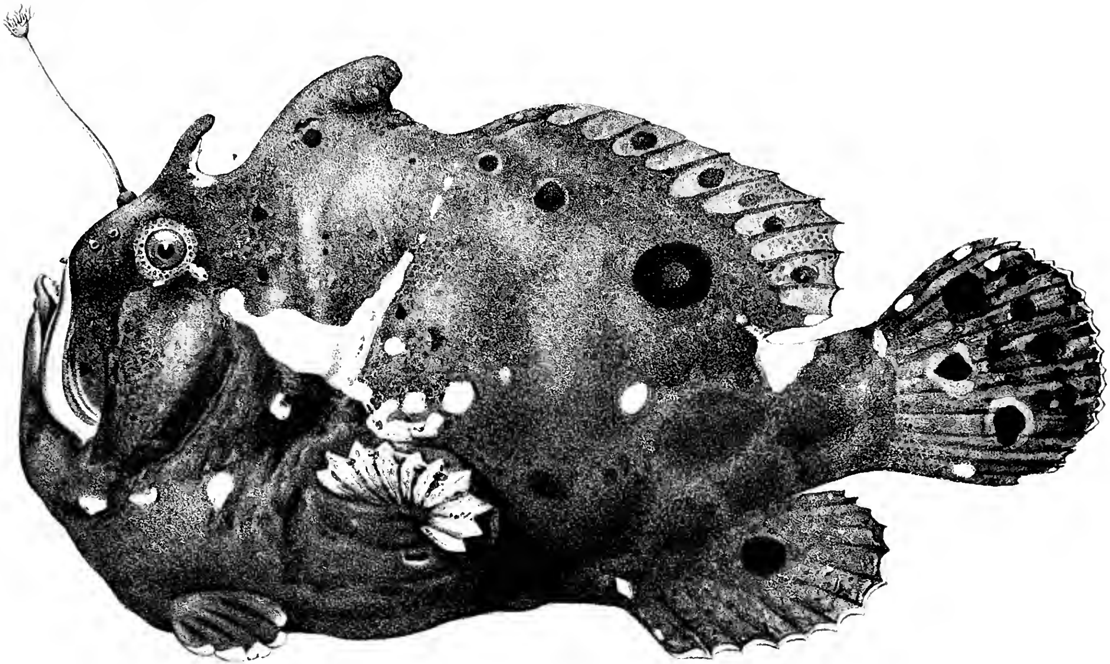


PLATE 4



The following Publications of the Museum of Comparative Zoölogy are in preparation: —

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows: —

E. EHLERS. The Annelids of the "Blake."
C. HARTLAUB. The Comatulae of the "Blake," with 15 Plates.
H. LUDWIG. The Genus Pentacrinus.
A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
R. T. HILL. On the Geology of the Windward Islands.
W. McM. WOODWORTH. On the Bololo or Palolo of Fiji and Samoa.
AGASSIZ and WHITMAN. Pelagic Fishes. Part II., with 14 Plates.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows: —

A. AGASSIZ. The Pelagic Fauna.
" The Panamic Deep-Sea Fauna.
H. B. BIGELOW. The Siphonophores.
K. BRANDT. The Sagittae.
" The Thalassicolae.
W. R. COE. The Nemerteans.
W. H. DALL. The Mollusks.
REINHARD DOHM. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
J. P. McMURRICH. The Actinarians.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
M. P. A. TRAUSTEDT. The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.
W. McM. WOODWORTH. The Annelids.

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AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to XLII., and also Vols. XLIV., XLV., and XLVII.; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVIII., XXIX., XXXI., and XXXII.

Vols. XLIII., XLVI., XLVIII., and XLIX., of the BULLETIN, and Vols. XXV., XXVI., XXVII., XXX., and XXXIII. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Professors and Assistants of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation: —

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, in charge of Professor N. S. Shaler.

These publications are issued in numbers at irregular intervals; one volume of the Bulletin (8vo) and half a volume of the Memoirs (4to) usually appear annually. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Librarian of the Museum of Comparative Zoölogy, Cambridge, Mass.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

VOL. XLVI. No. 8.

THE MAMMALS AND BIRDS OF THE PEARL ISLANDS, BAY OF PANAMA.

BY JOHN E. THAYER AND OUTRAM BANGS.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

SEPTEMBER, 1905.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUTENANT COMMANDER L. M. GARRETT, U. S. N., COMMANDING, PUBLISHED OR IN PREPARATION:—

A. AGASSIZ. General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
F. E. BEDDARD. The Earthworms.
H. B. BIGELOW. The Medusae.
R. P. BIGELOW. The Stomatopods.
S. F. CLARKE. The Hydroids.
W. R. COE. The Nemerteans.
L. J. COLE. The Pycnogonida.
W. H. DALL. The Mollusks.
C. R. EASTMAN. The Sharks' Teeth.
B. W. EVERMANN. The Fishes.
W. G. FARLOW. The Algae.
S. GARMAN. The Reptiles.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. The Schizopods.
S. HENSHAW. The Insects.
W. E. HOYLE. The Cephalopods.
C. A. KOFOID. III.[3] The Protozoa.
P. KRÜMBACH. The Sagittae.
H. LUDWIG. The Holothurians.
H. LUDWIG. The Starfishes.
H. LUDWIG. The Ophiurans.
J. P. McMURRICH. The Actinaria.
G. W. MÜLLER. The Ostracods.
JOHN MURRAY. The Bottom Specimens.
MARY J. RATHBUN. The Crustacea.
HARRIET RICHARDSON. II.[2] The Isopods.
W. E. RITTER. The Tunicates.
ALICE ROBERTSON. The Bryozoa.
B. L. ROBINSON. The Plants.
G. O. SARS. The Copepods.
F. E. SCHULZE. The Siliceous Sponges.
H. R. SIMROTH. The Pteropods and Heteropods.
TH. STUDER. The Alcyonaria.
T. W. VAUGHAN. The Corals.
W. McM. WOODWORTH. The Annelids.

[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z., Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.

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PRINTED FOR THE MUSEUM.

September, 1905.

No. 8. — *The Mammals and Birds of the Pearl Islands, Bay of Panama.*[1]

By John E. Thayer and Outram Bangs.

CONTENTS.

I. Introduction. By Outram Bangs.

During the John E. Thayer Expedition of 1904 Mr. W. W. Brown, Jr., made a second visit (his first expedition to the islands having been made in the spring of 1900) to the Archipelago de las Perlas in the Bay of Panama. Here he remained, collecting assiduously, for two months, — from the latter part of February to the latter part of April, 1904.

On his first trip, in 1900, Mr. Brown devoted much time to collecting mammals, and took specimens of probably every species that occurs in the islands, with the possible exception of some bats. He felt, however, that there were many birds in the islands of which he failed to secure representatives. The birds taken on the first expedition were also, many of them, in poor plumage, — some so worn and faded as to be misleading. On the first trip, also, Mr. Brown collected only in San Miguel Island, and took no reptiles or amphibians. It therefore seemed desirable that a second visit should be made.

On the present trip Mr. Brown collected on San Miguel, Saboga, and Pacheca Islands. The biota of all three is similar, and no species taken has differentiated on the several islands, owing to their closeness. San Miguel, being the largest island of the group, has the richest fauna, and many species occur there that are not found in the other islands. Saboga is the "bird rock" of the group, and here cormorants, boobies, man-o'-war birds, and terns breed in great numbers.

[1] Papers from the John E. Thayer Expedition of 1904, No. 2.

Pedro Gonzales and San Jose Islands were not visited; lying a little apart from the other islands, these two might prove to be interesting, but time did not permit of their being explored.

The vertebrates of the Pearl Islands are derived for the most part from the adjacent mainland, being either the same as, or slightly differentiated, island races of widely distributed Panamic forms. There are, however, some striking exceptions to this rule. Among the mammals, for instance, the nearest ally of the island vesper rat — *Zygodontomys seorsus* — seems to be *Z. brevicauda* of Trinidad; and a species of *Loncheres* allied to the Colombian *L. caniceps* occurs in the Pearl Islands, though the genus is as yet unknown from anywhere else north of South America proper.

Among the birds the more peculiar cases of distribution are the yellow honey-creeper, which is not nearly related to *Coereba mexicana* of the adjacent mainland, but finds its closest ally in *C. luteola* of the Caribbean coasts of Colombia and Venezuela; the *Phaëthornis* of the islands, which is related to *P. anthophilus* of central and eastern Colombia and Venezuela; and the ant wren, which, though very distinct, is a representative of *Formicivora intermedia* of Venezuela and Colombia.

Geologists appear to know very little about the Pearl Islands, and I can find nothing in print. Mr. Brown collected specimens of rock, and these, according to Professor Crosby, are of volcanic origin. From what little I can gather, I infer that the Archipelago de las Perlas has never been connected with the mainland since the elevation of the isthmus and the separation of the waters of the Bay of Panama from the Caribbean Sea.

The islands lie in the middle of the Bay of Panama, distant about twenty miles from the nearest point on the mainland. The larger ones are hilly and covered with a dense, luxuriant tropical forest, with the shores in many places fringed by mangroves. The waters of the Bay of Panama all about the islands are very deep.

The collections of reptiles, amphibians, and fishes will be reported upon in the third paper of this series.

Mr. Brown also made a small collection of trees and woody shrubs. These arrived in splendid condition and have been presented by Mr. Thayer to Prof. C. S. Sargent.

II. Literature. By Outram Bangs.

As the papers on Mr. Brown's first trip to the Pearl Islands were scattered, it is well to give a list of them here. They are as follows:

Bangs, Outram. Birds of San Miguel Island, Panama. Auk, vol. 18, pp. 24–32, January, 1901.

Bangs, Outram. A New Honey Creeper from San Miguel Island, Panama. Proc. New Eng. Zoöl. Club, vol. 2, pp. 51–52, Feb. 8, 1901.

Bangs, Outram. A New *Ortalis* from the Archipelago de las Perlas, Bay of Panama. Proc. New Eng. Zoöl. Club, vol. 2, pp. 61–62, July 31, 1901.

Bangs, Outram. The Mammals Collected in San Miguel Island, Panama, by W. W. Brown, Jr. Amer. Nat., vol. 35, pp. 631–644, August, 1901. (Actual date of distribution, Aug. 22, 1901.)

Bangs, Outram. Two New Birds from San Miguel Island, Bay of Panama. Proc. New Eng. Zoöl. Club, vol. 3, pp. 71–73, March 31, 1902.

Bangs, Outram. A New Wren from San Miguel Island, Bay of Panama. Proc. New Eng. Zoöl. Club, vol. 4, pp. 3–4, March 16, 1903.

Besides these papers very little has been published, except a description of a supposed new dove, *Zenaida hypoleuca* G. R. Gray MS. Mus. Brit. 1854; Bp. Consp. Av. II. p. 83, 1854. The specimen was collected by Captain Kellett and Lieutenant Wood, and was said to have come from the Pearl Islands (see under Aves of the present paper, species No. 31). One or two other birds are listed in the Catalogues of Birds in the British Museum from the same source.

Mention of birds and mammals described from the islands is of course made in lists and reviews since published, such as, —

Systematic Results of the Study of North American Land Mammals during the years 1901 and 1902, Miller and Rehn; Land and Sea Mammals of Middle America, Elliot; Hand-List of Birds, Sharpe; Birds of North and Middle America, Ridgway.

III. List of the Mammalia. By Outram Bangs.

The present trip added but little to our knowledge of the mammalian life of the Pearl Islands. No species was taken that Mr. Brown had not collected on his first visit to the islands in 1900. Mr. Brown, however, secured an additional example of the rabbit of the islands — *Lepus incitatus* — which was previously known by the type alone. This specimen, an adult female, taken in San Miguel Island, Feb. 29, 1904, is in

every way similar to the type, with the same peculiar skull with its broad, heavy rostrum.

I give a nominal list of the species of the islands here in order to make the paper complete as to the mammals. The species peculiar to the Pearl Islands are marked with an asterisk.

1. * *Marmosa fulviventer* Bangs.
2. *Didelphis marsupialis etensis* Allen.[1]
3. * *Lepus incitatus* Bangs.
4. * *Dasyprocta callida* Bangs.
5. * *Loncheres labilis* Bangs.
6. * *Proechimys burrus* Bangs.
7. * *Zygodontomys seorsus* Bangs.
8. *Mus musculus* Linné.
9. *Mus rattus rattus* Linné.
10. *Mus rattus alexandrinus* (Geoff.).
11. *Vampyrops helleri* Peters.
12. *Hemiderma breicaudum* (Wied.).

IV. Aves. By John E. Thayer and Outram Bangs.

On his first trip to the Pearl Islands Mr. Brown secured examples of forty-two species of birds, only two of which were North American migrants. On the present expedition he took representatives of ninety-two species. One species taken in 1900 — *Agamia agami* — was not obtained, and a dove — *Zenaida auriculata* — recorded from the Pearl Islands on the strength of a skin supposed to have been taken there by Captain Kellett and Lieutenant Wood, was not met with by Mr. Brown.

Thus the number of species of birds so far taken in the Pearl Islands is ninety-four, of which thirty-three are North American migrants, and sixty-one resident breeding birds of the islands.

It is rather strange that this considerable increase in the numbers of resident birds added but one new species, — the Booby, already described (Bull. M. C. Z., vol. 46, p. 92, June, 1905). All the others, with the possible exception of the rail, which we refer hesitatingly to *Aramides cajanea chiricote*, prove the same as mainland species.

The large series collected on the present trip shows one species,

[1] Allen, Bull. Amer. Mus. of Nat. Hist., vol. 16, Aug. 18, 1902, p. 262. I fail to see how this form from the continent and the Pearl Islands differs from *D. marsupialis battyi* Thomas, described from Coiba Island (Novit. Zoöl., vol. 9, p. 137, April, 1902). Dr. Allen, however, keeps them distinct in his review.

Ortalis struthopus, described by Bangs as peculiar to the islands, to be the mainland form, *Ortalis cinereiceps*.

Two new subspecies are described in the following list, — one a tyrant, of which Mr. Brown had previously taken but one example, and another, the blue tanager of the islands, which differs sufficiently from the mainland form to be considered a subspecies.

Unfortunately very little can be noted as to the habits of the birds. Mr. Brown states that in the islands, heavily forested right to high-water mark, the smaller birds all live in much the same manner, except that some keep to the underbrush and others to the trees, and that frequently one does not know what bird one has shot until it is secured.

In the following list North American migrants are marked with an asterisk, measurements are in millimetres, and the colors are according to Ridgway's nomenclature.

PHALACROCORACIDAE.

1. Phalacrocorax vigua vigua (Vieill.).

Sixteen specimens, adults and young, San Miguel and Saboga Islands, March and April. A nest placed in a tree containing six incubated eggs was taken, April 14, in Saboga Island.

SULIDAE.

2. Sula etesiaca Thayer and Bangs.

Seventeen specimens, adults of both sexes and young, San Miguel and Saboga Islands, March and April. No nests were found, the breeding season being apparently over.

FREGATIDAE.

3. Fregata aquila (Linne).

Three adults, ♂ ♂ and ♀, San Miguel and Saboga. A number of eggs were also taken.

ARDEIDAE.

4. Nyctanassa violacea (Linné).

Twelve specimens, adults and young, San Miguel and Saboga, March and April. A nest containing two fresh eggs was taken from a tree in San Miguel, March 14.

5. Agamia agami (Gmel.).

This bird was not observed on the present trip. One adult ♀ was taken in San Miguel, May 8, 1900, on Mr. Brown's former excursion to the islands.

6. Butorides virescens maculata (Bodd.).

Twenty-one specimens, adults and young, San Miguel Island, February and March. A nest containing one fresh egg was found March 15.

At first we thought this series represented a well-marked new form of the Little Green Heron, but on close comparison with considerable material from the West Indies we are unable to find a single character by which the Pearl Islands birds can be distinguished from *B. virescens maculata*. The skins agree in measurements with West Indian examples, as can be seen from the following tables. In color the Pearl Islands series presents the most astounding amount of individual variation. Some specimens have entirely lost all markings on the neck, this being dark maroon chestnut with a purplish bloom. Others have the neck normally striped and marked, agreeing exactly with birds from Cuba and the Lesser Antilles. Some have the throat white, others rufous, and others again have it either white or rufous heavily striped with black. The color of the belly varies from olive gray in some individuals to brownish slate color in others. The edgings to the wing coverts vary individually from whitish to rusty, and in some fully adult birds these edgings are broad and conspicuous, while in others they are very narrow, — almost wanting in one skin. In fact, among the adult birds it is hard to find two alike. The birds that have the neck uniform maroon-chestnut, or nearly so, have blacker bills than the others, with less yellow on the mandible. These skins represent a phase of plumage much like, if not the same as, the so-called *Butorides brunnescens* of Cuba, which most certainly is nothing but a phase of plumage of the ordinary species with which it occurs in Cuba. We have, as it happens, however, never seen intermediate examples from Cuba, all birds examined from that island being either in the *brunnescens* or the *maculata* phase. In the Pearl Islands series there is every stage of intermediate coloring.

This series, proving, as it does, that the Green Heron of the Panama region is the same as the West Indian, leads us to suppose that the range of this form includes the whole of southern Central and northern South America, where *Butorides virescens* meets and overlaps the range of *B. striata*.

Measurements of a series of Butorides virescens maculata.[1] —

No.	Locality.	Sex.	Wing.	Tail.	Tarsus.	Culmen.
14,891	Cuba, Halquin	♂ ad.	164.5	59.5	45	61
14,892	do.	♀ ad.	166	59	47	59.5
13,486	Isle of Pines, Santa Fé	♂ ad.	170	60	51	63

[1] Collection of E. A. and O. Bangs.

No.	Locality.	Sex	Wing.	Tail.	Tarsus.	Culmen
13,487	Isle of Pines, Bibeyhagua	♂ ad.	154	51	43	57.5
13,517	Dominica	♀ yg. ad.	164	59	47	56
13,578	do.	♀ yg. ad.	171	60	47	59
12,897	Bequia, Spring Est.	(?) ad.	171	60	49	61.5
12,896	do.	♂ ad.	171	63	49	63
12,626	Barbados	♀ ad.	168	59	49	60
12,629	do.	♂ ad.	165	58	43	57
12,627	do.	♀ ad.	163		46	58
13,212	Grenada, St. George	♂ ad.	168	60.5	49	57
8,902	Panama, Sona.	♂ ad.	175	61	48	61
14,260	Pearl Islands, San Miguel	♂ ad.	167.5	58.5	48.5	61
14,261	do.	♂ ad.	170	61	47	58
14,262	do.	♂ ad.	169	59	47	59.5
14,263	do.	♂ ad.	165	60	47.5	60
14,264	do.	♂ ad.	166	58	47	58
14,265	do.	♂ ad.	175	63	48	58.5
4,831	do.	♂ ad.	162.5	57	46	
14,266	do.	♀ ad.	163	58	45	57.5
14,267	do.	♀ ad.	163	59	43	57
14,268	do.	♀ ad.	164	57.5	45	61
10,538	Honduras, Ceiba	♂ ad.	174	62	50	60.5
3,423	Bahamas, Nassau	♂ ad.	167	59	44.5	58
14,994	Bahamas, Andros	♂ ad.	157	55.5	43	56

From these measurements it can be seen at a glance that the Pearl Islands Green Heron does not differ in size or proportions from birds from the West Indies and continental tropical America. There is a considerable individual variation in size in the Green Heron everywhere, but averages show that *B. virescens maculata* is easily separable from *B. virescens virescens* of eastern North America on account of its smaller size.

After examining a very large amount of material in this connection, we are forced to place very little reliance on color as a character by which to distinguish the various races of this species. Seasonal difference in this respect is very great, individual variation is also great, and in arid regions the bird bleaches out very fast. Mr. J. H. Riley in a recent publication[1] has stated: "Green herons from the West Indies, except the Bahamas, are smaller, have the crest more plumbeous, and the white edgings to the wing coverts are less pronounced and not so tawny in color when compared with Florida specimens." We cannot find a single one of these color characters stable, and furthermore are unable to separate Bahaman birds from those from other West Indian Islands killed at corresponding dates. Bahaman birds appear to bleach out and become very pale in summer, but so do birds in Barbados and Bequia, and

[1] Catalogue of a Collection of Birds from Barbuda and Antigua, B. W. I., Smith. Misc. Collections, vol. 47.

probably other more barren islands. The subspecies *maculata* also has a rufous phase — the so-called *B. brunnescens* — which thus far has been recorded from Cuba and the Pearl Islands only. That this is merely a phase of plumage is abundantly shown by the Pearl Islands series.

B. virescens anthonyi Mearns is certainly larger than *B. virescens virescens*, but how much its alleged paler color is due to season and to bleaching in its arid habitat remains to be proved. Young individuals, however, seem to have more white in the wing feathers. The two specimens upon which *Butorides virescens frazari* (Brewster) was based were killed in February, and appear to be in full winter plumage, and we cannot help predicting that a careful study of specimens killed at all seasons of the year will show that this is the name of the western bird, and that *anthonyi* is a synonym of it.

IBIDIDAE.

7. Eudocimus albus (Linné).

Four adults, both sexes, San Miguel and Pacheca Islands, March and April. An egg ready to be laid was taken from the oviduct of a bird killed April 14 in Pacheca Island.

CATHARTIDAE.

8. Catharistes urubu (Vieill.).

One female, Saboga Island, April 12.

FALCONIDAE.

9. Polyborus cheriway (Jacq.).

Two specimens, ♂ and ♀, Pacheca Island, April 14.

10. Milvago chimachima (Vieill.).

Fourteen specimens, young and adults of both sexes, San Miguel and Saboga Islands, April and March.

11. Buteo abbreviatus Cab.

Two specimens, ♂ and ♀, San Miguel Island, March 6 and 11.

12. Rupornis ruficauda (Scl. and Salv.).

Four specimens, both sexes, San Miguel Island, February and March.

13. Urubitinga anthracina (Licht.).

Two males, one adult, one young, San Miguel Island, March. These do not differ from mainland specimens.

14. Regerinus uncinatus (Temm.).

One ♂, beginning to attain to blue back of the adult plumage, Saboga Island, April 3. The naked parts are noted by Mr. Brown as "tarsus lemon yellow; skin of loral region flax flower blue, with a yellow spot in front of eye; iris dirty white."

15. Ictinea plumbea (Gmel.).

One adult, ♂, San Miguel Island, March 13.

TINAMIDAE.

16. Crypturus soui modestus (Cab.).

Six adults, both sexes, San Miguel Island, February and March. It is rather strange that the Tinamou of the Pearl Islands should be identical with that of the mainland, but such seems to be the case. We can detect no differences either in color or measurements.

CRACIDAE.

17. Ortalis cinereiceps (Gray).

Ortalis struthopus Bangs, Proc. New Eng. Zoöl. Club, vol. 2, pp. 61–62, July 31, 1901.

Seven adults, both sexes, San Miguel Island, February and March. This series shows that the supposed race from the Pearl Islands is not in any way different from the bird of the mainland. The present specimens are identical in color as well as in measurements with examples from Panama and Chiriqui. The type of *O. struthopus* marked "♂" is probably a female, wrongly sexed. The other original skin, No. 4882, adult ♀, from Pedro Gonzales Island, is the smallest in the whole series, and has the smallest and shortest foot and tarsus; it is probably a dwarf. Apart from this specimen, measurements of the island birds agree exactly with those of a series from the mainland, the males in all cases being much larger than the females.

RALLIDAE.

18. Aramides cajanea chiricote (Vieill.).

Four adults, both sexes, San Miguel, February and March.

These rails, when compared with a series from Panama and Chiriqui, are paler below and average smaller; there is such an amount of individual variation in size in both series, however, that this apparent difference might not hold good if still more material was measured. The paler color of the under

parts of the island birds also may not be a real difference, but is perhaps seasonal. Specimens measure as follows:

No.	Locality.	Sex.	Wing.	Tarsus.	Culmen.
14,297	San Miguel Island	♀ ad.	163	67.5	52
14,298	do.	♀ ad.	170	66	52
14,299	do.	♂ ad.	165	67	52
40,343	M. C. Z. do.	♂ ad.	169	67	53
7,060	Panama, Loma del Leon	♂ ad.	173	69	55
7,649	Chiriqui, Divala	♂ ad.	185	71	56.5
7,650	do.	♀ ad.	177	72	53.5

CHARADRIIDAE.

19. Haematopus palliatus Temm.

One adult, ♀, San Miguel Island, March 12. This example is rather small, but E. W. Nelson, who examined it during a study of the American Oyster catchers, considers its small dimensions as only the extreme of individual variation.

* 20. Arenaria interpres (Linné).

Three specimens, ♂ ♂ and ♀, San Miguel Island, February 27.

* 21. Squatarola squatarola (Linné).

One ♀, San Miguel Island, March 11.

* 22. Ochthodromus wilsoni (Ord.).

Three females, San Miguel Island, February 29 and March 11.

* 23. Aegialeus semipalmatus (Bp.).

Three specimens, ♂ ♀ ♀, San Miguel Island, March 4, 9, and 17.

* 24. Numenius hudsonicus Lath.

Three specimens, two females and a male, San Miguel Island and Saboga Island, February 24 and April 5.

* 25. Catoptrophorus semipalmata (Gmel.).

Two females, San Miguel Island, February 20 and March 2.

*26. Actitis macularia (Linné).

Five specimens, both sexes, San Miguel and Saboga Islands, March 1, 2, 10, and 17 and April 12. Two of these are spotted below, and three are in the white-bellied plumage.

*27. Ereunetes occidentalis Lawr.

One ♀, San Miguel Island, March 8.

*28. Limonites minutilla (Vieill.).

Three specimens, two males and a female, San Miguel Island, March 10.

LARIDAE.

29. Sterna maxima Bodd.

Two females, San Miguel Island, March 15.

COLUMBIDAE.

30. Columba rufina Temm. and Knip.

Ten adults of both sexes, San Miguel Island, February and March.

PERISTERIDAE.

31. Zenaida auriculata (Des Murs).

Though the Pearl Islands were so thoroughly collected by Mr. Brown, he never saw this dove, and the one specimen — the type of *Z. hypoleuca* Gray — obtained by Captain Kellett and Lieutenant Wood, if it really came from the islands, was probably a stray. It must be borne in mind that this is the only record for the species from north of Ecuador.

Unfortunately many of the birds collected by Kellett and Wood got mixed up, and any unusual record is hardly to be relied upon. While Gerrit S. Miller, Jr., was in the British Museum last winter, we asked him to examine the type of *Z. hypoleuca*, and also to look at other skins obtained on the same trip by Kellett and Wood. This Mr. Miller very kindly did in company with Dr. Sharpe. He informed us that the type of this dove had been injured by a taxidermist in making over, and so little of it remains that it is now impossible to state if it differed in any way from *Z. auriculata*. He also states that the Kellett and Wood skins were put in open tubes of paper and the data written on the tubes, that many got interchanged, and that no reliance can now be placed on the labels. As these officers collected down the west coast of

South America, it is very likely the dove in question never came from the Pearl Islands, or, as we have said above, if it did, its occurrence there must be looked upon as purely accidental.

32. Columbigallina rufipennis rufipennis (Bp.)

Twelve specimens, adults of both sexes, San Miguel and Saboga Islands, February, March, and April.

It might be expected that a bird of such feeble flight as the ground dove would become modified in some way upon these islands where so many other birds are different from their mainland representatives, but we are unable to find the slightest difference between the Rufous-winged Ground Doves of the Pearl Islands and the continent.

33. Leptotila verreauxi Bp.

Eleven specimens, adults of both sexes and young, San Miguel and Saboga Islands, February, March, and April.

If it should be found necessary to recognize the Central American form as *Leptotila verreauxi riottei* Lawr. (type from Navarro, Costa Rica)[1] on account of its slightly darker brown, back, wings, and upper surface of tail, the Pearl Islands bird will be included with true *L. verreauxi* of South America.

CUCULIDAE.

34. Crotohaga ani Linné.

Nine specimens, adults of both sexes and one young (March 28), San Miguel and Saboga Islands, February, March, and April.

PSITTACIDAE.

35. Amazona salvini Salvadori.

Seven adults, both sexes, San Miguel Island, March. We can find no constant differences between these and specimens from Panama and Chiriqui.

ALCEDINIDAE.

36. Ceryle torquata (Linné).

Five adults, both sexes, San Miguel Island, March.

[1] The range of this form extends from Costa Rica to Panama, while the paler true *L. verreauxi* occupies the whole of northern South America and the Pearl Islands.

37. Ceryle inda (Linné).

Five adults, both sexes, San Miguel Island, February and March.

BUBONIDAE.

38. Otus choliba (Vieill.).[1]

Six adults, both sexes, San Miguel Island, February and March.

In all probability the screech owl of the islands is not true *O. choliba*, but lack of material prevents us from forming any definite opinion.

CAPRIMULGIDAE.

39. Nyctidromus albicollis (Gmel.).

Five adults, both sexes, San Miguel Island, February and March.

The Parauque of the Pearl Islands does not differ from that of the mainland opposite, but to just what form the Panama bird should be referred is at present uncertain. As a rule specimens from Panama and Chiriqui are larger and darker than those from Guiana and Venezuela, but we have before us one skin from Divala, Chiriqui, of the same small rufous type that is the prevailing bird in Guiana and Venezuela. It is a ♂, and its wing and tail are half an inch shorter than in any other specimen from the same region, and its general coloration much more rufous. Can it be possible that these small rufous examples in reality belong to a species distinct from the larger darker bird? It is difficult to see how any other explanation can account for their presence in the same region with the other kind, and for their being so much alike, whether they come from Guiana or Chiriqui.

TROCHILIDAE.

40. Phaëthornis hyalinus Bangs.

Phaëthornis hyalinus Bangs, Auk, vol. 18, pp. 27–28, January, 1901.

Five adults, both sexes, San Miguel Island, February and March.

These specimens, exactly like the original three, confirm the characters of this well-marked island species.

41. Saucerottea edwardi (Delattre and Boure).

Eight adults, both sexes, San Miguel and Saboga Islands, March and April.

[1] One hardly recognizes "*Megascops brasiliana* (Gmel.)" under this name, but according to Von Berlepsch the bird must be known by this specific title, while Stone has shown that *Otus* must replace *Megascops*.

42. Chlorostilbon assimilis Lawr.

Nine adults, both sexes, San Miguel and Saboga Islands, February, March, and April.

PICIDAE.

43. Melanerpes seductus Bangs.

Melanerpes seductus Bangs, Auk, vol. 18, pp. 26–27, January, 1901.

Nine specimens, adults of both sexes, and one full-grown young male (March 11), San Miguel Island, February and March.

The woodpecker of the Pearl Islands is a well-marked island form of *M. wagleri*, but whether its differences are better expressed by a binomial or a trinomial is a question for some reviewer of the group to decide.

FORMICARIIDAE.

44. Thamnophilus nigricristatus Lawr.

Eight adults, both sexes, San Miguel Island, February and March.

45. Formicivora alticincta Bangs.

Formicivora alticincta Bangs, Proc. New Eng. Zoöl. Club, vol. 3, p. 71, March 31, 1902.

Thirteen specimens, adults of both sexes, and one young male, changing from a dress similar to that of the female to that of the adult male.

The adult males are similar to the two original specimens upon which this very distinct island species was founded. The female was previously unknown; it differs from the female of *F. intermedia* Cab. in being darker, richer brown above, and much more extensively ochraceous below. In one specimen the whole under parts, except throat and flanks, are of this color. It also wholly lacks the black subapical spots on the feathers of the chest, which in the female of *F. intermedia* form a sort of collar of semi-concealed spots.

46. Cercomacra nigricans Scl.

Cercomacra maculicaudis (Scl.) Bangs, Auk, vol. 18, p. 30, January, 1901.

Eleven specimens, adults of both sexes, and one young male in transition plumage, between that of the adult male and that similar to the female, San Miguel Island, February and March.

TYRANNIDAE.

47. Mionectes oleaginus oleaginus (Licht.).

Two specimens, male and female adult, San Miguel Island, February 24 and March 7. Like the first pair from the Pearl Islands, these two skins agree very well with South American examples, and are slightly larger and a little paler in color than *M. oleaginus parcus* Bangs of Panama.

48. Myiopagis placens accola Bangs.

Fifteen adults of both sexes, San Miguel and Saboga Islands, February, March, and April. These skins agree with specimens from Panama, but are slightly paler in color than the typical series from Chiriqui. The back is paler and grayer green, and the throat and breast slightly yellower, less grayish. In these points of difference from *accola* the island bird approaches *M. placens pallens* Bangs of northern South America (described from Santa Marta). On the whole, however, though somewhat intermediate, Panama and the Pearl Islands specimens should perhaps be referred to *accola*.

49. Ornithion pusillum (Cab. and Heine).

Eighteen specimens, adults of both sexes, and one young ♂ in nestling plumage (March 18), San Miguel, Saboga, and Pacheca Islands, March and April.

This fine series shows that the bird of the Pearl Islands does not differ from that of Panama. At the present time, however, we are not prepared to say that the Panama form is true *O. pusillum* which was described from Cartagena. The rather scanty and poor material examined from Colombia points to the two being subspecifically distinct, in which case the Panama race should bear the name, *Ornithion pusillum flaviventre* (Scl. and Salv.). The one nestling differs from the adults in having the cap less sharply defined and more nearly concolorous with the back, all the colors more blended, and the wing bars rufous instead of whitish or yellowish.

50. Elainea pagana subpagana (Scl. and Salv.).

Twenty-three adults, both sexes, San Miguel and Saboga Islands, February, March, and April.

There appear to be no constant differences between the island skins and those from the mainland of Panama and Chiriqui. The olive green of the back varies much in this series, and some specimens are very pale; others in which the plumage has become faded are very brown. In measurements the series varies a good deal, but this is also true of mainland specimens.

51. Elainea albivertex sordidata (Bangs).

Elainea sordidata Bangs, Auk, vol. 18, pp. 28–30, January, 1901.

Fourteen adults, both sexes, San Miguel Island, February and March.

It is claimed by Von Berlepsch and Hellmayr (Journ. f. Ornith. Januar-Heft, 1905, p. 2) that *Elainea sororia* Bangs from the Sierra Nevada de Santa Marta is identical with *E. albivertex* Pelz. of Brazil. The bird of the Pearl Islands seems a subspecies of this species, differing only in average characters. The present series bears out the slight differences noticed in the original description of *E. sordidata*—slightly shorter wing, tail, and tarsus, and longer and rather broader bill; slightly duller and grayer upper parts, smaller white crown patch and narrower wing bars. All these differences are, however, average characters only, and the subspecies is not a very satisfactorily marked one. Specimens from Panama City are troublesome; they are about the size of the island examples, and differ from them only in having slightly smaller bills. It is possible that *sordidata* is too slightly differentiated to stand even as a subspecies.

52. Sublegatus arenarum (Salv.).

Nineteen adults, both sexes, San Miguel and Saboga Islands, February, March, and April.

53. Myiodynastes audax nobilis (Scl.).

Four adults, both sexes, San Miguel, Saboga, and Pacheca Islands, March and April.

54. Myiobius naevius furfurosus, sub. sp. nov.

Myiobius naevius Bangs, Auk, vol. 18, p. 30, January, 1901 (nec. Bodd.).

Three specimens, two adult females, one adult ♂, Saboga Island, April.

Type. — Coll. E. A. and O. Bangs, No. 14,397, adult ♀, Saboga Island, Bay of Panama, April 9, 1904.

Characters. — Similar to true *M. naevius* (Bodd.) of South America (type from Guiana), but differing in being much more strongly buffy below, buff on throat and breast and buff yellow on belly and under tail coverts; the breast very much less distinctly striped with brownish; upper parts rather paler — about russet.

From *M. crypterythrus* Scl. of West Ecuador and *M. cryptoxanthus* Scl. of East Ecuador, the new form differs in its much paler brown back, though agreeing with the former in having the breast indistinctly flammulated.

Measurements. —

No.	Locality.	Sex.	Wing.	Tail.	Tarsus.	Culmen.
14,397	Saboga Isl.	♀ ad.	54	49	15.5	11
14,398	do.	♂ ad.	55.5	47.5	15.5	11
A.	do.	♀ ad.	54	48	15	10
4,876	San Miguel Isl.	♂ ad.	55.5	51	15.5	11.5

Remarks. — The three specimens contained in the present collection agree with one that Mr. Brown took in San Miguel Island on his first trip in 1900, and differ, as pointed out above, from all examples of true *M. naevius* we have examined. The bird is rare in the islands, and though specially on the lookout for it, Mr. Brown was unable to get a large series.

* 55. Empidonax traillii traillii (Aud.).

One adult male, Saboga Island, April 13.

* 56. Empidonax traillii alnorum Brewst.

Five adults, both sexes, Saboga Island, April 11 to 13. These have been kindly identified for us by Brewster, who pronounces five out of the six *Empidonax* taken by Mr. Brown *alnorum* and one true *traillii*.

* 57. Horizopus virens (Linné).

Four adults, both sexes, Saboga and Pacheca Islands, April 6 to 14.

58. Myiarchus ferox panamensis (Lawr.).

Twenty-four specimens, both sexes, San Miguel, Saboga, and Pacheca Islands, February, March, and April.

* 59. Myiarchus crinitus crinitus (Linné).

Two adult males, Saboga Island, April 9 and 13.

By a mistake Nelson recorded *Myiarchus nigriceps* Scl. from the Pearl Islands in his Revision of the North American Mainland Species of Myiarchus, Proc. Biol. Soc. Washington, vol. 17, pp. 49–50, March 10, 1904. The specimens collected by Mr. Brown loaned at the time were from San Miguel in the Sierra Nevada de Santa Marta, which Nelson mistook for San Miguel Island. The species has never been taken in the Pearl Islands.

* 60. Tyrannus tyrannus tyrannus (Linné).

Seven specimens, both sexes, San Miguel and Saboga Islands, March 18 to April 8.

61. Tyrannus melancholicus satrapa (Licht.).

Thirty-four adults, both sexes, San Miguel, Saboga, and Pacheca Islands, February, March, and April.

TURDIDAE.

*62. Hylocichla swainsoni (Cab.).

Two adults, ♂ and ♀, Saboga Island, April 8 and 11.

TROGLODYTIDAE.

63. Troglodytes musculus inquietus (Baird).

One adult male, San Miguel Island, March 18. This skin agrees in all respects with specimens from Panama. As it was the only house wren Mr. Brown saw in the islands on either trip, it may have come there by some accident.

64. Thryophilus galbraithii conditus Bangs.

Thryophilus galbraithii conditus Bangs, Proc. New Eng. Zoöl. Club, vol. 4, pp. 3–4, March 16, 1903.

Ten specimens, adults of both sexes, San Miguel Island, February and March. These, like the original specimens, are deeper in color and slightly larger than mainland examples of true *T. galbraithii*.

VIREONIDAE.

65. Vireosylva insulanus (Bangs).

Vireo insulanus Bangs, Proc. New Eng. Zoöl. Club, vol. 3, p. 73, March 31, 1902.

Twenty specimens, adults of both sexes, San Miguel and Saboga Islands, February, March, and April. The present series shows the same characters to distinguish the island bird from true *V. flavoviridis* Cassin as did the original four skins on which the form was based, — smaller size, duller color of back, and more pronounced lateral line of pileum and pale superciliary stripe. Still all these characters are average ones, and had not Ridgway in Birds of North and Middle America treated the bird as a distinct species, we should feel inclined to reduce it to a subspecies of *V. flavoviridis*.

*66 Vireosylva olivacea (Linné).

Five adults, both sexes, Saboga Island, April 7 to 12.

HIRUNDINIDAE.

67. Progne chalybea chalybea (Gmel.).

Five adults, both sexes, San Miguel Island, March. One colony of this dull-colored martin was nesting in the church at San Miguel; it was not seen elsewhere in the islands.

MNIOTILTIDAE.

*68. Protonotaria citrea (Bodd.).

Three females, San Miguel Island, February 24, March 2 and 13.

*69. Vermivora peregrina (Wils.).[1]

Three males, San Miguel Island, February 26 and March 1, Saboga Island, April 1. The specimen killed February 26 is moulting, as is also the one March 1, the olive green feathers of the cap being replaced by gray ones, and new feathers coming in on the throat and breast. The example taken April 1, however, is wholly in the plumage of the young in first autumn and shows no signs of approaching moult.

*70. Chrysocantor aestiva aestiva (Gmel.).

Twenty-five specimens, both sexes, San Miguel and Saboga Islands, February 21 to April 13. Many of these are in the moult; others, especially females, are in much abraded plumage.

71. Chrysocantor erithachorides (Baird).

Seventy-three specimens, San Miguel and Saboga Islands, February, March, and April.

These skins do not differ from examples from Panama. The series shows a considerable amount of individual variation, apart from that due to age. Several adult males are intensely colored, with the under parts much suffused with cadmium orange, the smaller wing coverts and yellow portion of the tail mostly of this color, and with the colors of the head very intense; others, apparently quite as old, are much duller. The extent of the rufous chestnut of the head varies from, in some skins, where it covers most of the chest to others where it ends at the throat. The rufous chestnut streaks on breast and sides vary much, in amount, in intensity of color, and in width. Some specimens have the back streaked with rufous chestnut, while usually it is plain yellowish olive green. In fact, it is difficult to pick out two skins quite alike.

[1] Cf. Oberholser, Smith. Mis. Collections, vol. 48, pp. 66–67, May 13, 1905, for change of generic name *Helminthophila* to *Vermivora*.

The females vary as much as the males. The fully adult female usually has some rufous chestnut in the crown, but the amount of this color is very variable, and a few, apparently fully adult, have none of it. The shade of yellow of the under parts and the amount of streaking below vary as in the males.

In the immature plumage, in both sexes, the belly and sides are dull whitish, the throat and chest yellowish, and the back and head much mixed with gray. No specimens were taken in nestling plumage, nor probably wholly in the second stage, in which the back and head would undoubtedly be wholly gray.

The species was common in mangrove swamps bordering the islands, much more so than in the mangroves near the city of Panama.

*72. Dendroica coronata (Linné).

One female, San Miguel Island, February 23.

*73. Dendroica rara (Wilson).

One female, San Miguel Island, March 15.

*74. Dendroica blackburniae (Gmel.).

Two males, Saboga Island, April 4 and 11.

*75. Dendroica castanea (Wilson).

Two males, San Miguel Island, March 6, and Saboga Island, April 3.

The specimen taken March 6 is in the midst of the spring moult, changing everywhere from autumn to spring plumage; the one taken April 3 has nearly, if not quite, completed the moult to its summer dress.

*76. Seiurus motacilla (Vieill.).

One female, San Miguel Island, March 18.

*77. Seiurus noveboracensis noveboracensis (Gmel.).

Three specimens, one male, two females, San Miguel Island, February 24 and March 8, and Saboga Island, April 9.

*78. Wilsonia canadensis (Linné).

One (female?) specimen, Saboga Island, April 4.

*79. Setophaga ruticilla (Linné).

One female, San Miguel Island, March 2.

COEREBIDAE.

80. Cyanerpes cyaneus (Linné).

Thirty-eight specimens, both sexes, San Miguel Island, February and March. There seem to be no differences between specimens from the islands and the coast of Panama opposite.

81. Coereba cerinoclunis Bangs.

Coereba cerinoclunis Bangs, Proc. New Eng. Zoöl. Club, vol. 2, pp. 51–52, Feb. 8, 1901.

Twenty-nine specimens, adults of both sexes and young in nestling plumage, the latter taken February 28 to March 16, San Miguel and Saboga Islands, February, March, and April. Many of the specimens taken in February and March are moulting, while those killed in April have, as a rule, completed the spring moult and are in fine plumage.

This is a strongly characterized island species.

ICTERIDAE.

82. Megaquiscalus major macrourus (Swainson).

Eighteen specimens, adults of both sexes, San Miguel and Saboga Islands, February, March, and April.

This series Nelson kindly compared with typical Mexican specimens, and found no differences whatever between the island birds and those from eastern Mexico and Central America generally.

*83. Icterus spurius (Linné).

One adult male, Saboga Island, April 13.

*84. Icterus galbula (Linné).

One male, San Miguel Island, March 2.

TANAGRIDAE.

85. Tanagra cana dilucida, sub. sp. nov.

Type. — Coll. E. A. and O. Bangs, No. 14,482, adult ♂, San Miguel Island, Bay of Panama, Feb. 25, 1904.

Thirty-one specimens, adults of both sexes and two young — male and female, March 3 and April 1, San Miguel and Saboga Islands, February, March, and April.

Characters. — Similar to *T. cana cana* Swainson, but larger with a larger bill; brighter blue, less greenish, on margins of wing and tail feathers; lesser and middle wing coverts darker and brighter blue — smalt blue; the contrast between colors of smaller wing coverts and bastard wing and edging of larger wing feathers not marked, as is the case in *T. cana cana;* rump and upper tail coverts, usually, decidedly bluer, less greenish.

Measurements. —

No.	Sex.	Locality.	Wing.	Tail.	Tarsus.	Exposed Culmen.
14,482	♂ ad.	San Miguel Isl.	92.5	66.5	19.6	15
A.	♂ ad.	do.	91	66	20	14.2
B.	♂ ad.	do.	93	66	20	14
C.	♂ ad.	do.	91	65	20	14.2
D.	♂ ad.	do.	93	67	19.8	14.4
40,556 M. C. Z.	♂ ad.	do.	92	62	20.2	14
40,557 M. C. Z.	♂ ad.	do.	92	63	19	14
40,558 M. C. Z.	♂ ad.	do.	91.5	64	20	14
40,559 M. C. Z.	♂ ad.	do.	91.5	64.5	20	14.2
4,984	♂ ad.	do.	92	64.5	19.2	14.2
4,986	♂ ad.	do.	92	64	20	14.8
14,485	♂ ad.	Saboga Isl.	92	64	19.4	14
14,487	♂ ad.	do.	93.5	67	20.4	14.8
I.	♂ ad.	do.	90	64	20	14
J.	♂ ad.	do.	92.5	64	20.4	14.2
K.	♂ ad.	do.	94	67.5	20.6	14
40,560 M. C. Z.	♂ ad.	do.	91	65	20	13.8
40,561 M. C. Z.	♂ ad.	do.	92	67	19.6	14.2
14,483	♀ ad.	San Miguel Isl.	88.5	62	20	14
N.	♀ ad.	do.	86.5	61	19.8	14
40,562 M. C. Z.	♀ ad.	do.	85.5	61	19.6	13.4
40,563 M. C. Z.	♀ ad.	do.	86.5	61	20	14
14,489	♀ ad.	Saboga Isl.	87	62	20	13.4
14,491	♀ ad.	do.	87	60.5	19.2	13.2

Remarks. — The combination of several slight differences distinguishes the blue tanager of the Pearl Islands from that of the mainland. Of these its larger bill is its best character. Its wings and tail average much brighter and darker blue, and the form averages a little larger. It is, however, a closely related subspecies, and some single individuals might prove troublesome, but in series the differences stand out fairly well.

*86. Piranga rubra rubra (Linné).

Three specimens, one male and two females, Saboga Island, April 5, 10, and 12.

* 87. Piranga erythromelas (Vieill.).

Two males, Saboga Island, April 9. Both these are in the scarlet plumage with black wings; one specimen has a *wholly yellow* bill.

88. Ramphocelus dimidiatus limatus (Bangs).

Rhamphocelus limatus Bangs, Auk, vol. 18, pp. 31, 32, January, 1901.

Forty-five adults of both sexes, San Miguel, Saboga, and Pacheca Islands, February, March, and April.

In Birds of North and Middle America, Ridgway treats this strongly marked island race as a subspecies. Perhaps this is the better course, but it is nevertheless a very distinct form.

FRINGILLIDAE.

89. Volatinia jacarini splendens (Vieill.).

Thirty specimens, adults of both sexes, and young males, San Miguel Island, February and March. Some examples, like the first two recorded from the islands, have larger bills than any in a considerable series of mainland specimens, but as a rule the bill is not larger than in the continental form.

90. Sporophila gutturalis (Licht.).

Two adult males, Saboga Island, April.

* 91. Cyanospiza cyanea (Linné).

One female, Saboga Island, April 6.

92. Oryzoborus funereus Sclater.

Ten adults, both sexes, San Miguel and Saboga Islands, March and April.

* 93. Zamelodia ludoviciana (Linne).

One female, San Miguel Island, February 28.

94. Saltator albicollis isthmicus (Scl.).

Thirty-six adults, both sexes, San Miguel and Saboga Islands, February, March, and April.

In Birds of North and Middle America Ridgway comments on the rather grayer colors of the original series from San Miguel Island taken in April and May. The present series includes many specimens in perfectly fresh unworn plumage. These are hardly distinguishable from mainland examples,

and we have found it impossible to pick out single skins. Still, as a whole, the bird of the Pearl Islands is a trifle darker and grayer olive green on crown and sides of head, and some examples are much more so than any from the mainland. It is possible that in time a recognizable form will be developed in the islands, but at present the slight differences are too inconstant to warrant giving the bird a name. Some examples have the end of the bill yellow (so marked on the labels by Mr. Brown), but usually it is dark-colored throughout.

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows: —

E. EHLERS. The Annelids of the "Blake."
C. HARTLAUB. The Comatulae of the "Blake," with 15 Plates.
H. LUDWIG The Genus Pentacrinus.
A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
R. T. HILL. On the Geology of the Windward Islands.
W. McM. WOODWORTH. On the Bololo or Palolo of Fiji and Samoa.
AGASSIZ and WHITMAN. Pelagic Fishes. Part II., with 14 Plates.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows: —

A. AGASSIZ. The Pelagic Fauna.
" The Panamic Deep-Sea Fauna.
H. B. BIGELOW. The Siphonophores.
K. BRANDT. The Sagittae.
" The Thalassicolae.
W. R. COE. The Annelids.
W. H. DALL. The Mollusks.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
J. P. McMURRICH. The Actinarians.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
M. P. A. TRAUSTEDT. The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.
W. McM. WOODWORTH. The Nemerteans.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to XLII., and also Vols. XLIV., XLV., and XLVII.; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVIII., XXIX., XXXI., and XXXII.

Vols. XLIII., XLVI., XLVIII., and XLIX., of the BULLETIN, and Vols. XXV., XXVI., XXVII., XXX., and XXXIII. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Professors and Assistants of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation: —

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, in charge of Professor N. S. Shaler.

These publications are issued in numbers at irregular intervals; one volume of the Bulletin (8vo) and half a volume of the Memoirs (4to) usually appear annually. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Librarian of the Museum of Comparative Zoölogy, Cambridge, Mass.

Bulletin of the Museum of Comparative Zoology

AT HARVARD COLLEGE.

VOL. XLVI. No. 9.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUT. COMMANDER L. M. GARRETT, U. S. N., COMMANDING.

III.

CRASPEDOTELLA, A NEW GENUS OF THE CYSTOFLAGELLATA, AN EXAMPLE OF CONVERGENCE.

BY CHARLES ATWOOD KOFOID.

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WITH ONE PLATE.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

SEPTEMBER, 1905.

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H. R. SIMROTH. The Pteropods and Heteropods.
TH. STUDER. The Alcyonaria.
T. W. VAUGHAN. The Corals.
W. McM. WOODWORTH. The Annelids.

[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z., Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.

Bulletin of the Museum of Comparative Zoology

AT HARVARD COLLEGE.

VOL. XLVI. No. 9.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUT. COMMANDER L. M. GARRETT, U. S. N., COMMANDING.

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CRASPEDOTELLA, *a new genus of the* CYSTOFLAGELLATA, *an example of convergence.* By CHARLES ATWOOD KOFOID.

In the plankton obtained by the Eastern Pacific Expedition of the U. S. Fish Commission Steamer "*Albatross*" in 1904–5 there occurred a Cystoflagellate belonging to the LEPTODISCIDAE which is of unusual interest not only because of its relationships, but especially on account of its striking resemblance in form to a craspedote medusa. The same organism subsequently appeared in the plankton collected in June at the San Diego Marine Biological Station of the University of California. It was first taken in the mid-Pacific at Albatross Sta. 4730, about 15° 7′ S., 117° 1′.2 W., midway between the Galapagos Islands and Manga Reva. This fact, together with its occurrence off the coast of Southern California, is indicative of a wide distribution in warm-temperate and tropical seas.

This organism is minute in comparison with *Leptodiscus medusoides* R. Hertwig (0.6–1.5 mm.) or *Noctiluca miliaris* Suriray (0.3–1.25 mm.), being only 0.15–0.18 mm. in diameter. Its form is campanulate, with a very well-defined horizontal velum. A large plasma mass is symmetrically pendent from the centre of the bell, whose cavity forms about two thirds of the volume of the organism. In polar view its outline is circular, and the orifice bounded by the velum is also of the same form. It is thus distinctly similar to a craspedote medusa in its form, resembling somewhat *Laodicea cellularia* A. Agassiz. The resemblance is further enhanced by the circlets of refractive granules found in the salient margins of the oblique band, while radial plasma strands in this band and in the velum suggest a muscular activity of the bell and resulting locomotion similar to that of a medusa. Its resemblance to

a medusa is thus even more striking than that of *Leptodiscus medusoides* described by R. Hertwig,[1] which is disk-shaped and lacks the velum. It seems probable that the ring of granules found in *Leptodiscus* may be the homologue of one of the two circlets found on either side of the oblique band in the organism here described.

In structural details it has much in common with *Leptodiscus,* but the presence of the velum justifies its generic distinction in the family LEPTODISCIDAE.

Craspedotella, gen. nov.

Medusiform, with a velum at the margin of the bell-cavity which has contractile walls.

Craspedotella pileolus, sp. nov.

Form low campanulate or cap-shaped, with a broad oblique band (*obl. bd.*) at the base, bordered above and below by salient ridges and continued toward the axis in a wide horizontal velum (*vel.*) with circular opening and entire margin. Its greatest diameter is located at the ridge above the oblique band and is 1.5 to 2 times its height. The bell opening is about 0.6 of the greatest diameter. A mass of richly vacuolated granular plasma fills the apex and spreads laterally nearly to the upper margin of the oblique band. Outside of this region the wall of the bell is thin, hyaline, and somewhat rigid, and its plasma resembles that of *Leptodiscus,* but has well-marked radial strands in the oblique band and in the velum. Within the central mass are found a large fluid-filled vacuole (*vac.*), a number of scattered food vacuoles (*f'd. vac.*), and the small ellipsoidal nucleus (*nuc.*). On the side of the bell, about midway between the apex and the oblique band, appears the minute pore of the flagellar sheath (*flag. sh.*) which extends about one half the distance to the apex as a straight tube just beneath the surface. Near the apex of the bell is the small cytopyge (*cyt'p'g.*), from which passes a sinuous canal soon lost in the plasma. Foecal accumulations similar to the scattered food particles were found in this canal. The food appears to consist principally of minute Algae, or their spores. On the under side of this bell at one side of the pendent mass of plasma is a large vestibulum (*vst.*) bounded laterally by a strand of plasma from the central mass. From its deeper end a tapering cytopharynx (*cyt'ph.*) sinks into the plasma and disappears near the apex of the bell in a

[1] Ueber *Leptodiscus medusoides* eine neue den Noctilucen verwandte Flagellate. Jena. Zeitsch. Bd. XI, pp. 307–323, Taf. XVII–XVIII, 1877.

somewhat denser mass of plasma not far from the nucleus. Its walls are coarsely striate, with a few prominent longitudinal ridges. Its opening is unquestionably *within* the bell and most careful scrutiny reveals no orifice on the outer surface.

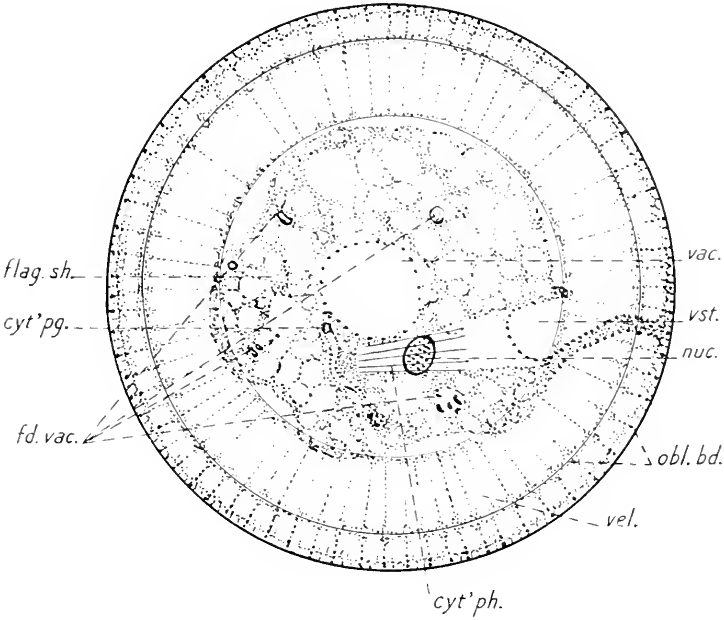
In *Leptodiscus* Hertwig describes the cytopharynx (*Cytostom*) as opening upon the upper (outer) surface of the curved disk on the same face as the flagellar sheath. In *Craspedotella* it unquestionably opens within the bell on the opposite face from the flagellar sheath. This seems to afford an additional ground for the generic distinctness of these two forms. The two organisms also diverge in other details of structure. In *Leptodiscus* the granular plasma is of small extent and very slightly protuberant, the pharyngeal striae are fine and close set, the cytopyge does not appear, the vacuole is small, and the peripheral plasma has less of a radial arrangement.

Adaptation to a pelagic life in the oceanic environment has resulted in the case of *Leptodiscus*, and still more in *Craspedotella*, in the development of a bodily form which bears a most striking resemblance to that attained by another and much higher group of organisms living under the same conditions. In *Craspedotella* there is differentiated even a superficial organ, the velum, with the accompanying bell-cavity, with form, relations, and possibly a function, similar to those of the corresponding organ in the medusa. The necessities of flotation and locomotion have brought about independently in the medusa and the cystoflagellate an external similarity in form, though the inner structural elements are exceedingly diverse in the two, and the one is a unicellular and the other multicellular organism, — an instance of convergence of the most striking character.

CRASPEDOTELLA PILEOLUS

FIG. 1. Apical view. Mag. 300 : 1.

FIG. 2. Lateral view. *Cyt'ph.*, cytopharynx. *vel.*, velum. *obl. b'd.*, oblique band. *vac.*, vacuole. *f'd. vac.*, food vacuole. *nuc.*, nucleus. *flag. sh.*, flagellar sheath. *Cyt'p'g.*, cytopyge. *vst.*, vestibulum.



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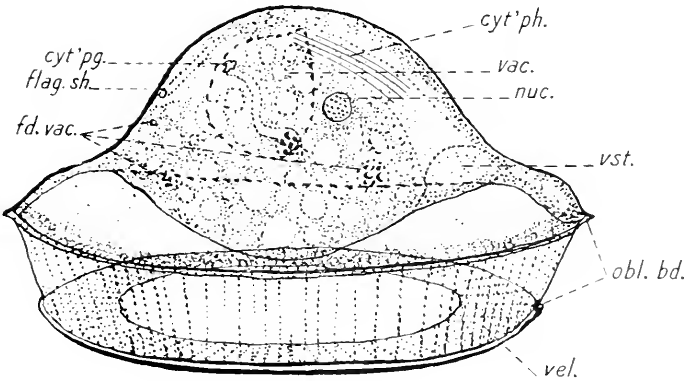

2

CRASPEDOTELLA PILEOLUS.

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows: —

E. EHLERS. The Annelids of the "Blake."
C. HARTLAUB. The Comatulae of the "Blake," with 15 Plates.
H. LUDWIG. The Genus Pentacrinus.
A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
R. T. HILL. On the Geology of the Windward Islands.
W. McM. WOODWORTH. On the Bololo or Palolo of Fiji and Samoa.
AGASSIZ and WHITMAN. Pelagic Fishes. Part II., with 14 Plates.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows: —

A. AGASSIZ. The Pelagic Fauna.
" The Panamic Deep-Sea Fauna.
H. B. BIGELOW. The Siphonophores.
K. BRANDT. The Sagittae.
" The Thalassicolae.
W. R. COE. The Annelids.
W. H. DALL. The Mollusks.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
J. P. McMURRICH. The Actinarians.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
M. P. A. TRAUSTEDT. The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.
W. McM. WOODWORTH. The Nemerteans.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to XLII., and also Vols. XLIV., XLV., and XLVII.; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVIII., XXIX., XXXI., and XXXII.

Vols. XLIII., XLVI., XLVIII., and XLIX., of the BULLETIN, and Vols. XXV., XXVI., XXVII., XXX., and XXXIII. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Professors and Assistants of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

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Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, in charge of Professor N. S. Shaler.

These publications are issued in numbers at irregular intervals; one volume of the Bulletin (8vo) and half a volume of the Memoirs (4to) usually appear annually. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Librarian of the Museum of Comparative Zoölogy, Cambridge, Mass.

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XLI.

ZUR ANATOMIE

VON

PENTACRINUS DECORUS WY. TH.

Von August Reichensperger.

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Mit Drei Tafeln.

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PRINTED FOR THE MUSEUM.

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XLI.

ZUR ANATOMIE

VON

PENTACRINUS DECORUS WY. TH.

VON AUGUST REICHENSPERGER.

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MIT DREI TAFELN.

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PRINTED FOR THE MUSEUM.

DECEMBER, 1905.

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XLI.

Zur Anatomie von Pentacrinus decorus Wy. Th. Von August Reichensperger.[1]

Das von mir benutzte Material stammt von der unter Leitung von Alexander Agassiz 1878–1879 zur Erforschung des Karibischen Meeres unternommenen Expedition des "Blake." Es bestand aus 25 zum Teil ganz unverletzten, gestielten Crinoiden, die ich nach P. H. Carpenter (5) sämtlich als "*Pentacrinus decorus*" Wy. Th. bestimmte.

Das Material erwies sich als gut konserviert. Die einzelnen Teile wurden in Schnittserien nach den verschiedensten Richtungen zerlegt. Zur Entkalkung bediente ich mich eines tropfenweisen Zusatzes von konzentrierter Salpetersäure zu relativ grossen oft erneuerten Mengen 70 %igen Alkohols. Mit besserem Erfolg wandte ich sehr schwache Chromsäurelösungen an. Zu 1000 ccm 1 %iger Chromsäure setzte ich 50 Tropfen Salzsäure oder bis 30 Tropfen Salpetersäure zu. Diese Mischung wurde in der ersten Zeit unter täglichem Wechsel auf ein Viertel mit destilliertem Wasser verdünnt, später langsam fortschreitend bis auf höchstens ½ gesteigert. Die durch blosse Anwendung von

[1] This paper has also been published in Vol. LXXX, Part 1, of the Zeitschrift für wissenschaftliche Zoologie. Specimens of *Pentacrinus decorus* were dredged by the "Blake" — off Havana, 175 and 177 fathoms; off Montserrat, 88 fathoms; and off St. Vincent, 124 fathoms.

Chromsäure leicht hervorgerufene Brüchigkeit der Gewebe war bei Gebrauch jener Mischung nicht zu bemerken. Zum Einbetten wurde ausschliesslich Paraffin genommen.

Als Färbemittel kamen vor allem Boraxkarmin, neutrales Karmin nach Hamann, sowie Hämalaun in Stückfärbung zur Anwendung. Stellenweise erwies sich Hämatoxylin in Verbindung mit Eosin als günstig. Sehr gut eignete sich für alle Gewebe, auch für die Kalkgrundsubstanz eine konzentrierte oder verdünnte wässrige Thioninlösung, ebenfalls unter allenfallsiger Nachfärbung mit Eosin. Thionin gab stets noch brauchbare Resultate, wenn viele andre Färbemittel der vorausgegangenen Entkalkung wegen versagten.

Es ist mir eine angenehme Pflicht, Herrn Geheimrat Professor Dr. Hubert Ludwig hier meinen besten Dank auszusprechen für die Überlassung des seltenen Materials und für seine liebenswürdige Bereitwilligkeit, mich jederzeit mit Rat und Tat zu unterstützen.

Einleitung.

P. H. Carpenter machte zuerst eingehendere Untersuchungen an *Pentacrinus decorus*, deren Ergebnisse in Bd. XI des Challengerwerkes niedergelegt sind. Er führt jedoch selbst verschiedentlich an, zur Erkenntnis des feineren Baues und Verlaufes mancher Organe sei das Material nicht in hinreichend gutem Zustande gewesen.

Zur allgemeinen Orientierung möchte ich zunächst auf die etwas umgeänderte Verkleinerung seiner Taf. LXII verweisen, Taf. III, Fig. 1.

Was die Benennung der Skelettteile des Kelches und der Arme anbetrifft, so verwende ich die von P. H. Carpenter in einer späteren Abhandlung (7) vorgeschlagenen Namen. In dem Challengerwerk (5) lässt er auf die den Boden des Kelches bildenden Basalia die Radialia I, II und III folgen. Von letzteren geht die erste dichotomische Teilung aus, die bei vielen Crinoiden die einzige bleibt. In dem 1890 erschienenen Aufsatz (7) belegt Carpenter die ehemals Radialia II und III genannten Kalkstücke mit dem Namen Costalia I und II. Verzweigen sich die Arme nun weiter, so heissen ihre Glieder bis zur folgenden Teilungsstelle, das sich teilende Glied eingeschlossen, Distichalia. Bei *Pentacrinus decorus* ist in der Regel noch eine dritte Spaltung vorhanden. Von der zweiten Teilung bis zu dieser letzten werden die Glieder als Palmaria bezeichnet. Weiterhin findet keine Verzweigung mehr statt, und die folgenden Glieder des Armes bis zur Spitze heissen Brachialia. Glieder, von denen eine dichotomische Teilung ihren Ausgang nimmt, werden axillare Glieder genannt.

Der Stiel zerfällt in Nodi, welche meist je fünf Cirren tragen, und in Internodia ohne solche.

Die Leibeshöhle des Kelches bildet bei *Pentacrinus decorus* ein zusammenhängendes Ganze, in welchem die Organe von bald stärkeren bald schwächeren Bindegewebssträngen gehalten und umsponnen werden. In diesen Bindegewebssträngen sind Kalkgebilde der verschiedensten Art enthalten, ähnlich, wie solche Ludwig (18) Taf. XVI. Fig. 39, wiedergegeben hat.

Annähernd in der Mittellinie durchzieht das "drüsige Organ," Carpenters "plexiform gland", den Kelch von oben nach unten, um sich in den Stiel fortzusetzen. Diese Fortsetzung des drüsigen Organs bezeichne ich als Achsenstrang; Ludwig gab diesen Namen bei *Antedon* der dorsalen Verlängerung des drüsigen Organs. Der Ausdruck P. H. Carpenters "central vascular axis of stem" birgt dagegen einen weiteren Begriff, da derselbe nicht nur die eigentliche Fortsetzung des drüsigen Organs, sondern auch die Ausläufer des gekammerten Organs darin zusammenfasste (5), S. 107.

Im Bereiche der Basalia ist dem drüsigen Organ das in fünf Teile zerfallende gekammerte Organ rings angelagert, welches sich ebenfalls röhrenförmig in den Stiel verlängert. Endlich treffen wir in den Basalia noch das Zentralorgan, den Knotenpunkt des umfangreichen antiambulacralen oder dorsalen Nervensystems, von welchem starke Stränge ausgehen, die dorsal durch die Kalkteile des Kelches und der Arme verlaufen.

In der Mitte der Kelchdecke liegt die Mundöffnung, in der sich die Ambulacralfurchen der Arme vereingen. Der Schlund geht fast senkrecht nach unten und macht mit seiner Fortsetzung, dem Darm, eine Drehung von links nach rechts. Nachdem der Darm in horizontaler Richtung den Kelch ringförmig durchlaufen hat, steigt er weider nach oben, um im interradial liegenden After zu enden.

Unter dem Epithel der Mundöffnung bemerken wir die oralen Teile des Wassergefass- und Blutgefasssystems und das ambulacrale Nervensystem. Ein weiteres, von Jickeli (15) vom ambulacralen Nervensystem bei *Antedon rosaceus* unterschiedenes, ventrales oder orales Nervensystem, welches Hamann (13) S. 72 später eingehender schilderte, habe ich bisher bei *Pentacrinus* nicht wahrgenommen.

Das für *Promachocrinus* und *Antedon* von P. H. Carpenter (4 und 5) beschriebene "schwammige Organ", welches er als besondern leicht durch dichtere Struktur kenntlichen Teil des labialen Blutgefässgeflechts abtrennt, stellt er selbst bereits für *Pentacrinus decorus* in Abrede (5) S.

100, und auch ich habe vergebens nach ihm gesucht. Dagegen fand ich einen umfangreichen Komplex von Zellen, welcher dem oberen Teil des "drüsigen Organs" angelagert ist. Dieses Komplexes finde ich an keiner Stelle Erwähnung getan, jedoch glaube ich, dass er in einer Zeichnung P. H. Carpenters (5) Pl. LVII, Fig. 3, angedeutet sein soll.

Gut entwickelt ist das "labial plexus" genannte labiale Blutgefässgeflecht, das mit dem oralen Blutgefässsystem in Verbindung steht und zu den intervisceralen Teilen der Leibeshöhle Ausläufer sendet. Ich halte dasselbe mit Ludwig (18) S. 47 nur für einen modifizierten Teil des oralen Blutgefässringes.

Den Bau der Arme fand ich, abgesehen von einer später zu berührenden Ausnahme, in der allgemeinen inneren Organisation im wesentlichen so, wie P. H. Carpenter (5) S. 88 ff., ihn schildert. Ich möchte daher auf das dort Gesagte verweisen.

1. Antiambulacrales Nervensystem.

1. Verlauf in Kelch und Armen.

Betrachten wir zunächst vom Zentralorgan ausgehend das antiambulacrale Nervensystem. Ludwig gab zuerst (18), Taf. XV, Fig. 38, ein Diagramm dieses Systems bei *Antedon rosaceus;* Hamann konstruierte (13) S. 65, ein ähnliches für die Gattungen *Antedon* und *Actinometra.*

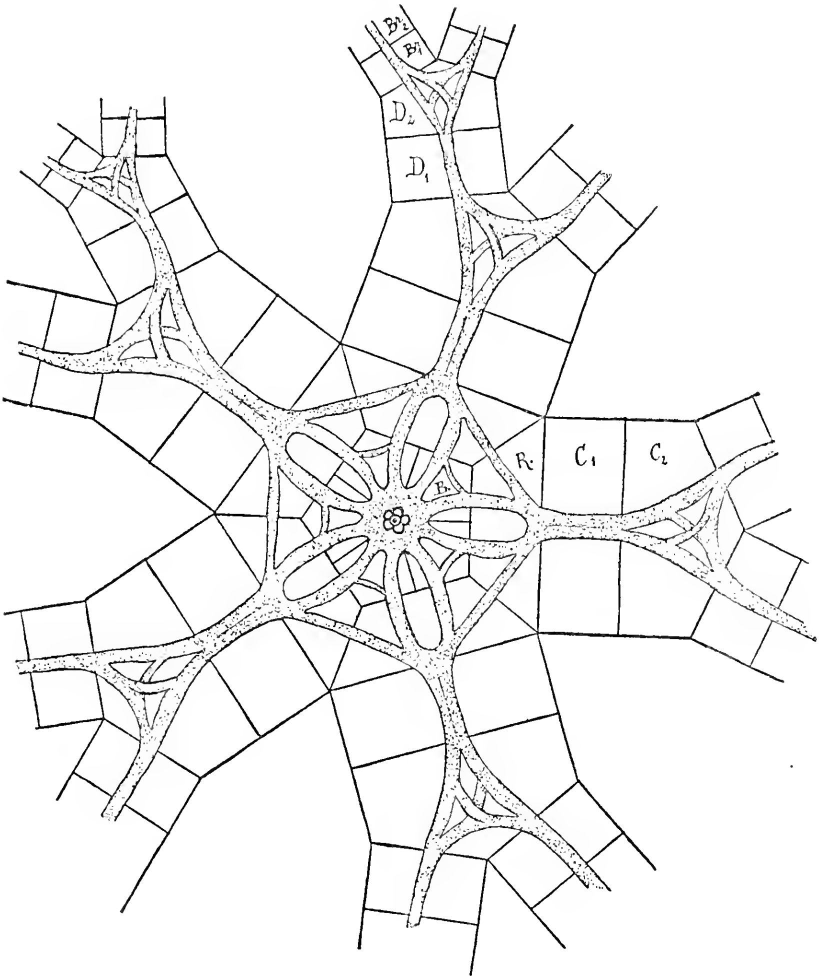
Pentacrinus decorus weist manche Verschiedenheiten von den genannten auf, wie ein Vergleich jener Diagramme mit dem von mir gegebenen dartut. Vgl. nebenstehenden Holzschnitt.

Das Zentralorgan selbst ruht knopfförmig in dem von den Basalia gebildeten Ring. In der Hauptmasse verlaufen seine Fasern von unten nach oben. In der Mitte wird es vom gekammerten Organ durchbrochen, das sich in den Stiel hinunterzieht.

Vom Zentralorgan gehen nun seitlich schräg nach oben hin zehn Äste aus, die, ein weniges divergierend, paarweise durch die Kalkgrundsubstanz der fünf Basalia verlaufen. Ehe sie diese verlassen, werden die beiden Stränge je eines Paares unter sich durch ein Connectiv verbunden, das nur etwa ein Drittel vom Durchmesser der Hauptäste besitzt. Letztere gehen zu je zweien parallel weiter durch die ersten Radialia, um sich an deren distalem Ende zu vereinigen. Die fünf Vereinigungspunkte werden durch einen sehr starken, horizontal verlaufenden Faserring miteinander verbunden. In den ersten Costalia finden wir nur einen Strang, der auf der Ober- und Unterseite meist eine mehr oder weniger flache Längsfurche aufweist, so dass ein Querschnitt durch denselben etwa Biskuitform hat.

In dem axillaren Costale II endlich treffen wir auf das Chiasma nervorum brachialium, dessen Bau bei *Antedon* Ludwig, Hamann und Perrier sehr eingehend geschildert haben.

Zunächst kann ich mit Gewissheit feststellen, dass ein erstes, bisher



von andern nicht bestätigtes Transversal-Connectiv, welches Perrier bei *Antedon* fand (21), T. IX, Pl. XVIII, Fig. 147 *cn* 1, bei *Pentacrinus* nicht vorhanden ist. Ferner vollzieht sich die Kreuzung der beiden eigentlichen Chiasmabündel erst sehr spät und in einem eher spitzen wie rechten Winkel. Hierdurch fällt sie erst in das Gebiet des breiten

transversalen Nervenzugs, während sie sich bei *Antedon* vorher vollzieht. Die beiden sich kreuzenden Stränge sind allgemein sehr viel stärker entwickelt wie bei *Antedon*. Man kann deutlich wahrnehmen, dass ein gegenseitiger Faseraustausch in ihnen auch bei *Pentacrinus* nicht stattfindet, vielmehr ein Strang quer über den andern wegläuft.

Bi- und multipolare Ganglienzellen finden sich in den Hauptästen nicht selten, im Chiasma selbst sind sie sehr vereinzelt, aber dann von bedeutender Grösse, 0,012 bis 0,009 mm, und mit starken Fortsätzen versehen.

Ausser den fünf in den axillaren Costalia II befindlichen Chiasmata finde ich keine weiteren erwähnt. Bei zehnarmigen Crinoiden sind sie naturgemäss die einzigen, welche vorhanden sein können. Die Zahl der Arme schwankt bei *Pentacrinus* von 10 bis 25; durchschnittlich teilen dieselben sich zwei- bis dreimal. Wie verhält sich bei diesen weiteren Teilungen der Nervenstrang?

Auf tangentialen Längsschnitten findet man in jedem axillaren Distichale und Palmare ebenfalls ein gut ausgebildetes Chiasma, dessen Dimensionen natürlich mit der Entfernung vom Kelch abnehmen. Die sich kreuzenden Stränge sind aber nicht, wie man erwarten sollte, um die Hälfte, sondern nur um etwa ein Drittel dünner, wie die des vorausgegangenen Chiasma. Nach Messungen an zwei Exemplaren betrug ihr Durchmesser durchschnittlich im:

Chiasma costale	0,118 mm
Chiasma distichale	0,076 mm
Chiasma palmare	0,049 mm

Auf Taf. XXIV des Challenger-Werkes (5) gibt Carpenter verschiedene Querschnitte durch die Basis eines Kelches von *Pentacrinus wyville-thomsoni* wieder, welchem *Pentacrinus decorus* sehr nahe steht. Er zeichnet dort Fig. 9 den horizontal durch die Radialia verlaufenden Faserring, aber keine Connective in den Basalia.

Vergleicht man das von mir gegebene Diagramm von *Pentacrinus decorus* mit den von P. H. Carpenter (5) konstruierten des *Rhizocrinus lofotensis* S. 253, des *Bathycrinus aldrichianus* S. 229, und mit dem von Hamann (13) S. 65 für die Gattungen *Antedon* und *Actinometra* festgestellten, so sieht man, dass das antiambulacrale Nervensystem der beiden ersten Arten ungleich einfacher gebaut ist, wie das von *Pentacrinus*. Bei beiden Arten geht in jedem Basale vom Zentralorgan nur ein Strang aus, der sich bei *Rhizocrinus* unmittelbar vor dem Verlassen der Basalia, bei *Bathycrinus* erst in den Radialia in zwei Äste spaltet.

Dagegen teilt sich bei *Antedon* und *Pentacrinus* jeder Basalstrang sogleich nach dem Austritt aus dem Zentralorgan in zwei Stränge. Während diese aber bei *Pentacrinus* zu je zweien durch ein Connectiv verbunden sind und im übrigen paarweise parallel durch die Radialia verlaufen, fehlt bei *Antedon* das Connectiv in den Basalia, und die zwei Stränge vereinigen sich beim Übergang in das Radiale, um als ein solider Strang weiter zu ziehen.

Allen genannten Familien kommt ein stark entwickelter Faserring in den Radialia zu. Bei *Rhizocrinus* liegt er zum kleineren Teile in den Basalia, wodurch seine Sternform zustande kommt; bei den andern liegt er stets ganz innerhalb der Radialia und hat die Form eines mehr oder minder abgerundeten Pentagons.

Einen Vergleich zwischen dem Verlauf der Faserstränge von *Antedon* und *Encrinus*, für welch letztere, auf dicyklischer Basis beruhende Gattung, Beyrich ein Diagramm konstruierte, zieht Ludwig (18), S. 66, und schliesst von anatomisch-vergleichendem Standpunkt wichtige Bemerkungen an. Er kommt zu dem Schluss, dass der äussere Kreis der eigentlichen Basalia von *Encrinus* den Basalia von *Antedon* entspricht.

Was den Zweck der Connective und sonstigen Verbindungen der Nervenstränge anbetrifft, so scheint mir derselbe an erster Stelle in der Schnelligkeit von Reizübertragungen zu liegen. Ein auf einen Arm ausgeübter Reiz kann unmittelbar auf den benachbarten übertragen werden, ohne zuerst den Weg zum Zentralorgan und von dort zurück machen zu müssen.

Hinsichtlich des feineren histologischen Baues muss ich mich vollständig Perrier (21) und Hamann (13) anschliessen. Der letztere beschreibt (13) S. 87, auch speziell den Bau der Armnerven von *Pentacrinus decorus*; ganze Tiere standen anscheinend nicht zu seiner Verfügung. Ich sehe hier von einer Schilderung des dorsalen Nervenstranges in den Armgliedern ab, da ich den Auseinandersetzungen Hamanns wesentliches nicht hinzuzufügen habe, um mich dem Faserverlauf im Stiele zuzuwenden.

2. Verlauf des Nervensystems im Stiel.

In Fig. 1 und 7 *b* sehen wir, wie das Zentralorgan des antiambulacralen Nervensystems in seiner Mitte von sechs Röhren durchbrochen wird. In der mittleren Kammer verläuft der Achsenstrang; die äusseren fünf sind Fortsetzungen des gekammerten Organs.

Das ganze Bündel von Röhren wird im Stiel seiner Länge nach von einer ziemlich dicken Schicht meist senkrecht von oben nach

unten verziehender Nervenfasern umhüllt. Grosse Ganglienzellen trifft man in dieser Schicht während des Verlaufs durch Internodien verhältnismässig selten an; vereinzelte liegen am Aussenrande. Ein Belag stark färbbarer kleiner Kerne trennt in den Internodien fast überall die Faserschicht von der benachbarten Kalkgrundsubstanz der Stielglieder.

In den Nodien, oberhalb und unterhalb der Abgangsstelle der Cirrengefässe, gehen die peripherischen Fasern der Nervenschicht seitlich auseinander, ziehen in der Richtung auf die Gefässe hin und bilden auf diese Weise einen horizontalen Ring, wie Fig. 3 darstellt. In der Substanz dieses bald schwächer, bald stärker ausgebildeten peripherischen Ringes finden wir zahlreiche grosse bi- und multipolare Ganglienzellen. Einmal liegen sie in der Mitte zwischen je zwei Cirrengefässen, dann aber vornehmlich auch unmittelbar neben der Ursprungsstelle der letzteren aus den Kammern. Im weiteren Verlauf bleiben die Cirrengefässe zunächst allseitig ganz gleichmässig von der dem Ringe entstammenden Nervenschicht umhüllt (Fig. 4). Verlassen sie aber das Nodium, um in das erste, eigentliche Cirrusglied überzugehen, so rückt die Fasermasse mehr und mehr auf die Seiten, und oben und unten bleibt nur ein dünner Belag, wie das Fig. 5 zeigt. Derselbe verdickt sich wieder ein wenig an der Stelle, wo in jedem Cirrusgliede, von den vier Ecken der das Gefäss umhüllenden Schicht ausgehend, Nervenzüge zur Innervierung der Haut und der Gelenkverbindungen abgegeben werden.

3. Funktion des antiambulacralen Nervensystems.

Die Funktion des Zentralorgans und der von ihm ausgehenden dorsalen Stränge ist sehr verschieden beurteilt worden. W. B. Carpenter war der erste, der dem gesamten Komplex nervöse Natur beilegte und seine Meinung auch auf eine Reihe von interessanten Experimenten an lebenden Tieren der Gattung *Antedon* zu stützen suchte. Ludwig (18) S. 80 fasste dagegen das dorsale Nervensystem als unverkalkt gebliebenen Teil des skelettbildenden Gewebes mit Nährfunktion auf. Inzwischen wies P. H. Carpenter in den Strängen grosse Ganglienzellen nach und W. B. Carpenter trat nochmals in einer ausführlichen Abhandlung (9) für seine Ansicht ein. Jickeli (15) S. 367, Perrier (21) und Hamann (13) gaben nähere Einzelheiten über den Bau und die Verteilung der bi- und multipolaren Ganglienzellen an, und letzterer beschreibt auch S. 66, 67 die Struktur der feinen Fasern, um zu dem Schluss zu kommen, dass es echte Nervenfasern seien.

A. M. Marshall wiederholte (20) die Experimente, welche W. B.

Carpenter an lebenden Tieren angestellt hatte und fügte eine bedeutende Anzahl neuer hinzu. Er kommt zu der Ansicht, dass das Zentralorgan und seine Verlängerungen das Hauptnervensystem bildeten. Das subepitheliale, ambulacrale Nervensystem scheint ihm nur sehr untergeordnete Bedeutung zu haben (op. cit. S. 35).

Demgemäss wird nunmehr der ganze Komplex fast allgemein als ausschliesslich nervöser Natur angesehen. Allerdings sind in den Strängen keinerlei bindegewebige Elemente anzutreffen, aber dennoch kann ich ohne eine Einschränkung der eben genannten Auffassung nicht beipflichten.

P. H. Carpenter sagt selbst (5) S. 116: "I have no doubt whatever, that the axial cords are permeated by a nutritive fluid, which finds its way into the substance of the organic basis of the skeleton;" und ferner berichtet er von Zweigen, welche ihm überzugehen scheinen: "into the plexus of tissue forming the organic basis of the skeleton." Das nicht seltene Vorkommen solcher Zweige kann ich nur bestätigen. — Mitunter gehen vornehmlich vom dorsalen Armstrang rasch sich verjüngende Ausläufer aus, deren feinste Enden fern von Muskeln oder ähnlich gebauten Fasern im Kalkgrundgewebe verlaufen. Sie besitzen stellenweise eine dünne Decke von kleinen Kernen, dagegen mangeln ihnen grosse Ganglienzellen gänzlich. Fig. 6 gibt dies Verhalten wieder. Vergebens versuchte ich diese Ausläufer bis an die Haut oder wenigstens bis in deren Nähe zu verfolgen.

Häufiger noch und besser sind derartige Abzweigungen in den oberen Teilen des Stieles wahrzunehmen, in welchen die Neubildung weiterer Kalkglieder vor sich geht, wo also die Frage der Ernährung eine bedeutende Rolle spielt. Sie gehen innerhalb des Stieles von dem Nervenstrang aus, der die Cirrengefässe umhüllt, und zwar meist unter einem rechten Winkel nach oben oder unten. Diese Ausläufer verjüngen sich kaum wahrnehmbar und durchziehen weithin die Grundsubstanz fast stets ohne sich zu verzweigen. Sie sind von zahlreichen Kernen begleitet und stellenweise mit winzigen stark tingierbaren Körnchen übersät, deren Natur mir einstweilen zweifelhaft erscheint, die ich aber jedenfalls für ein Coagulum halten möchte. Auch P. H. Carpenter fand solches häufig in den Nervensträngen (5) S. 116. Die Fasermasse der Ausläufer ist gering entwickelt, aber unverkennbar vorhanden. Ganglienzellen habe ich an oder in diesen Zügen niemals zu Gesicht bekommen.

Da mir in den genannten Fällen eine Innervierung sensitiven oder motorischen Charakters ausgeschlossen scheint, halte ich eine trophische Nebenfunktion der Stränge für sehr wahrscheinlich.

Hamann wies bereits aufs bestimmteste (13) S. 68 die Behauptung von Vogt und Yung zurück, es stellten die Nervenstränge bei *Antedon rosaceus* mit geronnener Flüssigkeit erfüllte Röhren von weitem Lumen dar (25) S. 560, Fig. 277. Für *Pentacrinus* kann ich nur nochmals mit P. H. Carpenter (5) S. 113 ff. feststellen, dass es sich lediglich um solide Faserstränge handelt, die weder Hohlräume noch Scheidewände aufweisen.

II. Das "gekammerte Organ" und die Cirrengefässe.

Eine Zusammenfassung der Ansichten der verschiedenen Forscher über das gekammerte Organ von *Antedon* gibt Hamann (13) S. 101. Bei *Pentacrinus decorus* besteht es aus fünf Kammern oder richtiger Röhren, welche sich nach unten verengen und in den Stiel fortsetzen, nach oben hin den Achsenstrang und weiterhin das "drüsige Organ" (Dorsalorgan) umfassen, um bald blind zu endigen.

Verfolgen wir Gestaltung und Verlauf an der Hand der Abbildungen. Fig. 7 *a* zeigt einen Querschnitt im Stiel. Fünf Röhren liegen mit ihrer Aussenwandung im Kreise seitlich aneinander und bilden in der Mitte eine sechste Kammer, in welcher der Achsenstrang verläuft. Figur *b* und *c* zeigen, wie weiter oberhalb, bei Übergang in den Kelch, die Kammern an Grösse zugenommen haben und bereits von der Fasermasse des eigentlichen Zentralorgans umhüllt sind. Die folgende Zeichnung *d* gibt einen Querschnitt in Höhe des in den Basalia befindlichen Nervenconnectivs wieder. Der Kelch hat sich hier erweitert und seine Höhlung ist von kalkführendem Bindegewebe nach allen Richtungen durchzogen, welches an die Aussenwände der fünf Kammern herantritt. Letztere haben sich voneinander getrennt und vom Achsenstrang etwas entfernt. Später nähern sie sich der Mitte wieder, jede Kammer verjüngt sich rasch, und ihre Wandung geht in das Cölomepithel über, welches das drüsige Organ umhüllt. Ihr Hohlraum dagegen findet keinerlei Fortsetzung, weder im drüsigen Organ, noch in der Leibeshöhle, wird vielmehr durch feines Bindegewebe nach oben abgeschlossen (Fig. 7 *g*).

Bei *Antedon* fand W. B. Carpenter (8) S. 219, ventralwärts eine Öffnung in jeder Kammer und brachte letztere daher mit der Leibeshöhle in Verbindung. Ludwig beobachtete Kanäle, welche sich den ventralen Öffnungen W. B. Carpenters anschlossen, um zum Achsenstrang, bzw. drüsigen Organ hinzuziehen (18) S. 63 und Fig. 21. Ebenso hält P. H. Carpenter (5) S. 104 das gekammerte Organ für fünf Radiärgefässe, welche sich verbreitern und mit dem drüsigen Organ

in enger Beziehung stehen. Perrier (21) S. 24 ff. verfolgte die allmähliche Entwicklung des gekammerten Organs bei *Antedon rosaceus* und kommt zu dem Schlusse, dasselbe bilde einen geschlossenen Raum, der sich nicht in das drüsige Organ fortsetze. In gleichem Sinne spricht sich Hamann (13) S. 103 aus: " Es gehen von dem eigentlichen gekammerten Organ fünf blindgeschlossene röhrenförmige Hohlräume ab, welche neben dem axialen Strang verlaufen, um bald blind zu endigen, wie ich mit grösster Sicherheit aussprechen kann (Taf. VII, Fig. 1)."

Bei *Pentacrinus decorus* habe ich in den Wandungen des gekammerten Organs keinerlei Öffnungen gefunden, auch fehlen die bei *Antedon* nach oben hin sich erstreckenden röhrenförmigen Verlängerungen oder Kanäle; vielmehr endet das Organ fast unmittelbar nachdem es seine grösste Breite erlangt hat. Dieser Unterschied von *Antedon* ist offenbar nur quantitativer Art, indem eine Verkürzung der Röhren oder Kanäle bei dieser Art zu der Form des Organs führen würde, wie wir sie bei *Pentacrinus* angetroffen haben. Wahrscheinlich wird bei letzterem eine solche Verlängerung nach oben unterdrückt durch das die ganze Kelchhöhle erfüllende Bindegewebe, welches bei *Pentacrinus* ungleich stärker wie bei *Antedon* entwickelt ist.

Im obersten Teile der Kammern bemerkt man im Innern von Wand zu Wand ziehend unverkalktes, feinfaseriges Bindegewebe. Ausserdem findet man überall im Innern zerstreut zahlreiche, grosse, tiefdunkle Körner von amorpher Gestalt. Dieselben bilden ein nicht zu verkennendes Merkmal für alle zum gekammerten Organ gehörigen Teile. Nirgends sonst sind derartige Gebilde anzutreffen, weder in benachbarten Teilen des drüsigen Organs, noch im umgebenden Bindegewebe der Leibeshöhle. Dies scheint mir ein Beweis mehr dafür zu sein, dass die Kammern ein in sich geschlossenes Ganze bilden. Auch Perrier (21) S. 24 ff. stellte ähnliche Körner bei *Antedon rosaceus* fest, und sagt, er habe sie ausschliesslich auf das gekammerte Organ beschränkt gefunden, was demnach vollständig mit meinen Beobachtungen in Einklang steht.

In den Nodien des Stiels geht von jeder Kammer des Organs, bzw. seiner Verlängerung, ein Gefäss in die Cirren ab. Einen Teil eines horizontal durch ein Nodium geführten Schnittes gibt Fig. 8 wieder, einen Teil eines Vertikalschnittes Fig. 9. Die Fortsetzungen der Kammern nehmen in den Nodien etwas an Umfang zu. Ihre distale Wandung biegt nach aussen hin aus und zeigt eine länglich ovale Öffnung, den Beginn der Cirrengefässe. Das Epithel der Kammern setzt sich in letztern ringsum fort und kleidet ihre Innenwand aus.

Jedes Gefäss wird von einem horizontal durch die Mitte laufenden Septum in eine obere und eine untere Hälfte geteilt. Das Septum bildet sich von der proximalen Kammerwand her und durchquert die Kammer. Es besteht aus einer sehr feinen Bindegewebslage, die beiderseits mit einem epithelartigen Belag von Zellen versehen ist. Seine Dicke schwankt zwischen 0,0048 und 0,0067 mm. Muskelfasern habe ich nicht in ihm gefunden. — Zu Anfang zeigen die Cirrengefässe im Querschnitt eine länglich ovale, von oben nach unten gestreckte Form, runden sich aber bald ab. Mit dem Achsenstrang stehen sie bei *Pentacrinus decorus* in keinerlei Beziehung.

Unter den mir vorliegenden Exemplaren befand sich eines mit stark verkümmerter fünfter Kammer. Demgemäss hatten sich an jedem Nodium nur vier Cirren entwickelt. Selbst die Gelenkgrube zur Aufnahme des ersten Cirrusgliedes, die bei *Pentacrinus* im allgemeinen stark ausgebildet ist, war an der fünften Seite kaum wahrzunehmen.

Für Erkenntnis der noch immer fraglichen Funktion des gekammerten Organs, das Hamann mit Bury seiner Entstehung nach als Enterocölraum ansprechen möchte (13) S. 107, wäre es von Bedeutung, zu wissen, wie es sich im letzten Stielgliede verhält. Da bei allen mir zur Verfügung stehenden Tieren der Stiel weiter oberhalb abgebrochen war, konnte ich nicht feststellen, ob die Kammern an ihrem unteren Ende gleichfalls geschlossen sind, oder ob sie mit der Umgebung in freier Kommunikation stehen. Letzteres scheint mir weniger wahrscheinlich, da auch bei *Antedon* und *Actinometra* das gekammerte Organ, abgesehen von den Ausgängen der in die Cirren führenden Gefässe, nach unten hin geschlossen ist, wie Hamann (13) S. 104 mitteilt.

Cuénot (10), Bosshardt (3) S. 105 und andre berichten, dass die Bewegungen der Cirren von *Antedon* sehr zögernd und langsam erfolgen und dieselben sich in dieser Beziehung in weitgehender Weise von denjenigen der Arme unterscheiden. Im vollen Gegensatz hierzu erwähnt A. Agassiz von einer Anzahl *Pentacrinus*, die er während einiger Stunden lebend hielt: "They use the cirri more rapidly, then the arms, and use them as hooks, to catch hold of neighbouring objects. . . ." — Weitere Angaben über die Bewegungen der Cirren bei den gestielten Crinoiden liegen meines Wissens nicht vor.

III. Das "drüsige Organ" (Dorsalorgan).

1. Der Achsenstrang.

In der Röhre, welche in der Mitte des kalkigen Stieles liegt, und die von den fünf Kammern des gekammerten Organs gebildet wird, befindet

sich ein langer dünner Strang, P. H. Carpenters axis of stem im engeren Sinn, den ich nach Ludwig als Achsenstrang bezeichne. Seine Fortsetzung im Kelch bildet das drüsige Organ. Genauere Einzelheiten finde ich bei P. H. Carpenter über den Bau dieses Stranges nicht angegeben. Er rechnet ihn anscheinend zum gekammerten Organ und sagt nur (5) S. 107, derselbe bilde in den Stielteilen "a singular vessel (5) Pl. XXIV, fig. 2—5 V.

Bei den mir vorliegenden Exemplaren von *Pentacrinus* beträgt der Durchmesser des Achsenstrangs etwa 0,009–0,0165 mm, und zwar verjüngt er sich nicht nach unten hin, sondern hat, soweit ich ihn durch den Stiel verfolgen konnte, überall annähernd gleichen Umfang. Er setzt sich aus ursprünglich kugeligen Zellen zusammen, die sich seitlich gegeneinander abplatten. Fig. 11 bringt einen Quer-, Fig. 10 einen Längsschnitt. Man bemerkt auf ersterem eine einreihige, ringförmige Zellschicht, welche in der Mitte ein unregelmässig gestaltetes, stets sehr kleines Lumen freilässt. Die Zellgrenzen sind nur undeutlich zu erkennen. Der Zellinhalt ist fein granuliert, wie auch der Inhalt der Kerne. In letzteren befinden sich meist noch grössere Körnchen, deren Zahl schwankend ist. Die Gestalt der Kerne ist länglich oval. Sie lagern sich im allgemeinen gegen das innere Lumen hin. Ihre Grösse bewegt sich zwischen 0,0011 · 0,0031 und 0,002 · 0,0043 mm.

Der Achsenstrang hängt seiner ganzen Länge nach frei in dem von den Fortsetzungen des gekammerten Organs gebildeten Raume; es ist mir wenigstens nicht gelungen, Fasern oder bindegewebige Stränge zu finden, die an ihn seitlich von den Kammerwänden her herantreten. Ebensowenig fand ich in diesem Raume die oben erwähnten für das gekammerte Organ bezeichnenden dunkeln Körner; es scheint demnach auch im Stiel keine Kommunikation zwischen den Fortsetzungen des gekammerten Organs und der Röhre des Achsenstrangs zu bestehen.

2. Das eigentliche "drüsige Organ."

Schon ehe der Achsenstrang in den Kelch übergeht, hat sich sein Umfang etwas vergrössert. An Stelle der einfachen Zellreihe treten mehrere Schichten. In diesen bilden sich Faltungen, so dass das innere Lumen halbmondförmig wird (Fig. 7 *d*). Weiter nach oben hin kann man zwei, vier und mehr Lumina erkennen. Es kommt sehr bald zur Bildung einer grösseren Zahl von Schläuchen, die sich im weiteren Verlauf verzweigen und in ihrer Gesamtheit kleine Krümmungen machen. In Höhe der Darmwindung finden sich dann häufig S- und U-förmige seitliche Ausbiegungen einzelner Schläuche, die sich regellos durchein-

ander schlingen. Sie bedingen den verwickelten Aufbau des drüsigen Organs, dessen Zusammensetzung bei *Antedon* nach Perrier (21) Pl. XX, Fig. 162, einfacher zu sein scheint. Die allgemeine Richtung der Schläuche ist auch bei *Pentacrinus* von unten nach oben, doch gehen nicht selten in horizontaler Richtung kürzere Ausläufer ab, welche bald blind endigen. Ob alle Schläuche miteinander kommunizieren, ist mir zweifelhaft geblieben; für eine beschränkte Anzahl kann man auf günstigen Längsschnitten einen Zusammenhang nachweisen.

Solange die Schläuche im Boden des Kelches nicht sehr zahlreich sind, treten sie zu einer bald kreisförmigen, bald mehr eckigen Röhre zusammen, deren ziemlich weites Lumen von einem Netzwerk von zartem Bindegewebe durchquert wird (Fig. 7 *g* und *h*). Die zunehmende Zahl der Schläuche lässt das Lumen bald enger werden; das Bindegewebe verschwindet. An seiner umfangreichsten Stelle, die bei *Pentacrinus* zwischen der Darmwindung liegt, setzt sich das drüsige Organ folgendermassen zusammen: Aussen gegen die Leibeshöhle hin treffen wir zunächst das umhüllende Cölomepithel; nach innen zu folgt die Masse der teils quer-, teils längsgetroffenen Schläuche. Ungefähr in der Mitte dieser ziemlich kompakten Masse findet sich ein freies Lumen, von Vogt und Yung (25) S. 562 "leere Achse" genannt. Gegen diese ist die Gesamtheit der Schläuche wiederum durch ein mit dem Cölomepithel übereinstimmendes Epithel begrenzt. Ich möchte nach allem die "leere Achse" als einen abgekapselten Teil der Leibeshöhle betrachten, eine Ansicht, die allerdings nur durch entwicklungsgeschichtliche Arbeit mit voller Sicherheit bewiesen werden kann. Bindegewebe ist sehr spärlich zwischen den einzelnen Schläuchen vorhanden, vor allem im untersten Teil des drüsigen Organs. An keiner Stelle fand ich die Schläuche ganz von dichtem Bindegewebe umhüllt, wie das Hamann (13) S. 114, und Taf. IX, Fig. 4, 5, 12 und 13 von *Antedon* darstellt; nur eine feinfaserige bindegewebige Membran mit spärlichen Kernen umzieht bei *Pentacrinus* jeden Schlauch nach aussen hin, wie das durch meine Fig. 13 veranschaulicht ist.

Ziemlich weitgehende Übereinstimmung herrscht bei beiden Gattungen im Bau der Schläuche selbst. Die zylindrischen Zellen, aus welchen die Wand der letzteren gebildet wird, erscheinen, abgesehen von ihrer viel bedeutenderen Grösse, den Zellen des Achsenstranges ähnlich. Sie werden bis 0,042 mm hoch, bei einer durchschnittlichen Breite von 0,016 mm. Die Kerne liegen im allgemeinen mehr der Aussenseite des Schlauches zu. Die Substanz der Zellen zeigt eine feinere, die der Kerne eine gröbere Körnelung. In den oberen Teilen des drüsigen

Organs trifft man im Innern der Schläuche mitunter feines Gerinnsel an, was mir auf einen Zusammenhang mit dem Blutgefässsystem hinzudeuten scheint.

3. Der dem drüsigen Organ angelagerte Zellkomplex.

Verfolgen wir das drüsige Organ von seiner breitesten Stelle an weiter nach oben hin, so treffen wir sehr bald auf einen merkwürdigen Komplex von Zellen, den ich nirgendwo erwähnt order beschrieben finde. Der Umfang desselben schwankt bei den einzelnen Tieren ziemlich bedeutend; seine Form bleibt im allgemeinen annähernd die gleiche. Eine Andeutung dieses Komplexes glaube ich nur bei P. H. Carpenter (5) Pl. LVII, Fig. 3 zu finden. Er rechnet ihn offenbar zu seinem "labial plexus" und lässt das mit *gv* bezeichnete Genitalgefäss aus ihm entspringen.

Die erwähnte Zellmasse bildet eine mehr oder weniger umfangreiche, ovale, stark ausgebuchtete Scheibe von verschiedener Dicke, die sich mit ihrem unteren Rande und den Seitenrändern meist vertikal an das drüsige Organ anlegt. Ventralwärts, in der Nähe der Mundöffnung jedoch, hängt sie mit den Endausläufern des drüsigen Organs nicht zusammen. Letzteres bildet also mit dem Zellkomplex einen oben offenstehenden Sack. Im Innern desselben treffen wir vereinzelte, schwach entwickelte, unverkalkte Bindegewebsstränge und eine grosse Anzahl feinerer Blutgefässe an. Die Wiedergabe eines Längs- und eines Querschnittes, Fig. 15 und Fig. 14, verdeutlicht das Verhalten der einzelnen Teile.

P. H. Carpenter schildert (5) S. 100 das labiale Blutgefässgeflecht, labial plexus, welches mit dem oralen Blutring in Verbindung steht und sich aus einer Menge feiner und feinster Röhren zusammensetzt. Von einem Teile desselben treten Gefässe von oben her in den Sack ein und wenden sich nach allen Seiten zu den Innenwänden; einerseits münden sie an Stellen des drüsigen Organs, anderseits in den erwähnten Zellkomplex. Stellenweise sind sie in solcher Anzahl vorhanden, dass fast der ganze Innenraum des Sackes ausgefüllt ist. Ob diese Blutgefässe mit den Schläuchen des drüsigen Organs in direkter Verbindung stehen, konnte ich nicht mit Gewissheit feststellen, halte es aber für sehr wahrscheinlich; dass sie aber in das spärlich vorhandene umgebende Bindegewebe eindringen und sich dort verzweigen, habe ich mit Sicherheit wahrgenommen. Dagegen bestreitet Hamann (13) S. 114, entschieden ein Eintreten der Blutflüssigkeit in die Lumina der Schläuche bei *Antedon*, um dann fortzufahren: "sie kann höchstens in der Binde-

substanz des Organs ihren Verlauf nehmen, doch habe ich sie auch hier nicht beobachten können."

Mit Gewissheit gelang es mir ferner, mich davon zu überzeugen, dass die zu dem fraglichen Zellkomplex gehenden zahlreichen Blutgefässe in diesen eintreten. Betrachten wir den Bau desselben etwas genauer. Sein Aussenepithel setzt das des drüsigen Organs unmittelbar fort und zeigt die gleichen Zellelemente; sie sind bald mehr kubisch, bald etwas abgeflacht und besitzen deutliche Kerne. Unter dem Epithel verlaufen stellenweise in verschiedenen Richtungen bindegewebige Gefässe. Weiter nach innen folgt ein solides Polster von ziemlich grossen, dicht zusammenschliessenden Zellen, wie Fig. 16 zeigt. Dieselben sind rundlich bis polygonal gegeneinander abgegrenzt. In der Mitte der Scheibe befinden sich grössere, rings nach dem Rande zu kleinere Zellen. Sie färben sich etwas weniger intensiv, wie die Elemente des drüsigen Organs. Ihre Kerne sind von verhältnismässig bedeutender Grösse.

Die Grösse des gesamten Zellkomplexes, der auf etwas dickeren Schnitten schon mit blossem Auge leicht kenntlich ist, schwankt sehr erheblich; im allgemeinen findet man ihn bei weiblichen Tieren ein wenig stärker ausgebildet wie bei männlichen. Der am kräftigsten entwickelte hatte nach meinen Messungen eine durchschnittliche Dicke von 0,077 mm; seine Breite betrug 1,058, seine grösste Länge 2,414 mm. Einer der kleineren Komplexe hatte dagegen nur 0,048 mm Dicke, 0,73 mm Breite und etwa 1,54 mm Länge. Ebenso verschieden der Grösse nach verhielten sich die Elemente, welche das aus 8–14 Zellreihen bestehende Polster bildeten. Bei einem sehr gut konservierten weiblichen Exemplar liess eine Eisenhämatoxylinfärbung genaue Messungen zu. Demnach bestimmte ich die Grösse einzelner Zellen und ihrer Kerne auf:

Zelle	Kern
0,0076 mm	0,0037 mm
0,0078 "	0,0035 "
0,0095 "	0,005 "
0,0103 "	0,0062 "
0,0109 "	0,0068 "
0,0112 "	0,0068 "
0,0132 "	0,007 "
0,0184 "	0,0088 "
0,0187 "	0,0091 "

Aus der Mitte der Aussenfläche der Scheibe geht ein Gefäss von beträchtlichem Durchmesser hervor. Es verläuft in Richtung auf die

Kelchdecke hin und hält sich meist zunächst in der Nähe des Schlundes, um sich später mit Genitalgefässen in Verbindung zu setzen. Dasselbe ist aus einer ziemlich starken Bindegewebsschicht gebildet und zeigt ein deutliches Aussenepithel. Auch im inneren Lumen finden sich mitunter sehr feine Bindegewebsstränge; ob diese bereits hier eine besondere Innenröhre bilden, wie das in den Genitalsträngen der Fall ist, oder nur von Wand zu Wand ziehen, ist mir sehr zweifelhaft geblieben. Helleres und dunkleres Gerinnsel trifft man in dem Gefäss sehr häufig an.

Der Zellkomplex setzt sich nach oben hin bis unterhalb des Integuments der Kelchdecke fort. Seine Dicke nimmt langsam ab. Neben der Mundöffnung angelangt macht er eine fast rechtwinklige Biegung und steht als sehr feiner Strang anscheinend mit dem zwischen dem ambulacralen Nervensystem und dem Wassergefässsystem verlaufenden oralen Blutgefässring in engerer Verbindung.

Diesen bei *Pentacrinus decorus* dem drüsigen Organ angelagerten Zellkomplex halte ich nun für den Bildungsherd der Urkeimzellen, eine Meinung, die ich in den folgenden Abschnitten ausführlicher zu begründen hoffe. Zugleich möchte ich zeigen, dass Blutgefässsystem und Genitalgefässsystem in engem Zusammenhang miteinander stehen. Ich wende mich zu diesem Zweck an erster Stelle der Anordnung und dem Bau der Generationsorgane in den Armen zu, da derselbe dort am deutlichsten erkennbar ist.

IV. Die Generationsorgane.

1. Bau und Verlauf der Genitalstränge in den Armen und Pinnulae.

Bei P. H. Carpenter (5) S. 110 finde ich folgende Bemerkung: "... The ovaries of the *Pentacrinidae* are likewise long and fusiform, some of them appearing to present somewhat anomalous characters. For in some sections, which were made for Sir Wyv. Thomson by Dr. Stirling, the ovary appears in the arm, occupying the usual position between the subtentacular and the coeliac canals, where the sterile genital cord is normally found. This is also the case in the lower parts of the arms of *Holopus rangi*, Pl. V, *c*, fig. 2, but I have not yet succeeded in discovering which species of *Pentacrinus* or *Metacrinus* is distinguished by this peculiarity; for the sections above mentioned were not labelled with any name or reference number. I have cut sections of the arms of all the more common *Pentacrinus*, but in none of them have I found any such departure from the type of the ordinary *Antedon* as is presented by the ovaries of this unknown species."

Lang, (16) S. 1090, nimmt wohl auf diesen Passus bezug, wenn er einer ausnahmsweisen Reifung von Gonaden im Arme einer unbekannten Art Erwähnung tut.

Pentacrinus decorus ist nach allen von mir untersuchten Exemplaren getrenntgeschlechtlich und zwar bargen die Arme in ihrem ganzen Verlauf nahezu reife männliche oder weibliche Geschlechtsprodukte, ja bereits in den meisten Kelchscheiben waren solche vorhanden. Ich kann daher eine Anormalität nicht annehmen, halte vielmehr den Zeitpunkt des Fanges der mir vorliegenden Tiere für besonders günstig gelegen. Gehen wir im folgenden näher auf die Einzelheiten ein.

In dem zwischen Dorsal- und Ventralkanal befindlichen Genitalkanal — ich wähle die Bezeichnungen, die Ludwig (18) einführte — verläuft ein dünnwandiger Schlauch, der ein weites Lumen besitzt. Derselbe wird durch bald stärkere bald schwächere Bindegewebsstränge in der Mitte des Genitalkanals aufgehangen. In diesem Schlauch befindet sich ein engerer mit sehr feiner Wandung. In dem Stadium der Geschlechtsreife, in welchem die von mir untersuchten Tiere sich befanden, erfüllte der innere Schlauch fast das ganze Lumen des äusseren. Die Aussenwand des inneren Schlauches liegt dann zum weitaus grössten Teile der Innenwand des äusseren Schlauches an, so dass sie oft sehr schwer erkennbar ist. Nur nach oben zum Ventralkanal hin bleibt ein freier Raum zwischen den Wandungen, dessen Durchmesser bei vorgeschrittener Entwicklung der Keimzellen etwa ein Viertel des Ganzen beträgt. Die Fig. 17, 18 und 19 geben hiervon ein Bild.

Bereits Ludwig, dem wir die ersten genauen Beobachtungen über den Bau der Generationsorgane von *Antedon* verdanken, hielt den äusseren Schlauch, welcher die eigentliche Genitalröhre umschliesst, für zum Blutgefässsystem gehörig und bezeichnete ihn als Genitalgefäss oder Genitalschlauch, (18) S. 30 ff. Andrer Ansicht ist Hamann, (13) S. 117 und 118, der ein Vorhandensein von Blutflüssigkeit im Genitalschlauch der Crinoiden in Abrede stellt und keinen Zusammenhang mit den Blutlakunen der Scheibe auffand. Ich muss entschieden Ludwig beipflichten. Fast regelmässig fand ich bei *Pentacrinus* feine Körnchen, Gerinnsel, Reste von Blutserum in den Genitalgefässen, wie das aus den Figuren ersichtlich ist. Ferner ist der Bau derselben dem der echten Blutgefässe gleich. Die dünne, aus bindegewebigen Längsfasern gebildete Wand ist von einem feinen Aussenepithel überzogen, dessen Kerne ziemlich dicht aneinanderlagern und scharf hervortreten. Endlich stehen die Genitalgefässe des Kelches in enger Beziehung zu dem labialen Blutgefässgeflecht, wie wir weiter unten sehen werden.

Ringmuskeln, wie sie Ludwig bei *Antedon* (18) S. 31 erwähnt, habe ich in der Wandung der Gefässe nicht gefunden. Auch ist bei *Pentacrinus decorus* die Genitalröhre nicht im Genitalgefäss durch feine, spindelförmige Fasern aufgehangen, wie Ludwig (18) Taf. XIII, Fig. 14 von *Antedon* darstellt, sondern sie liegt, wie oben gesagt, zum grössten Teil der Innenwand des Gefässes an.

Die Genitalröhre besteht aus einer sehr schwachen mit kleinen zerstreuten Kernen versehenen einfachen Bindegewebslamelle. In ihrem Innern befinden sich Samen- oder Eizellen, und zwar trifft man in einem Arme im allgemeinen zwei sehr verschiedene Stadien der Eizellen an, umfangreiche Zellen von etwa 0,135 mm und gering entwickelte von rund 0,028 mm Durchmesser. Es wäre denkbar, dass letztere zu Nahrungszwecken resorbiert werden, jedoch könnten diese kleineren Keimzellen auch eine später folgende Generation bilden, da ich direkte Verfallstadien an ihnen nicht konstatieren konnte. In weiter distal liegenden Teilen der Arme und in den Pinnulae finden sich meist nur Eier einer Grösse vor. Weder in den Pinnulae, noch in Armen oder Kelch findet sich eine Follikelbildung, wie Perrier für *Antedon rosaceus* (21) Pl. 19, Fig. 156 und 157 angibt.

Vollkommen reife Eier, d. h. solche, deren Keimbläschen verschwunden war, und die bereits Richtungskörperchen ausgestossen hatten, wie Hamann (13) S. 121 und Taf. XII, Fig. 4 *a* von *Antedon eschrichti* beschreibt und zeichnet, waren bei meinen Exemplaren noch nicht vorhanden. Die weiter unten folgende Tabelle lässt aber erkennen, wie das Keimbläschen im Verhältnis zu der ganzen Eizelle in den Brachialia höherer Ordnung an Grösse abnimmt. Die in der Entwicklung vorgeschrittenen Eier zeigen fast stets im Keimfleck zwei bis fünfzehn stark lichtbrechende Körnchen, wie das Ludwig bereits von *Antedon* erwähnt, (18) S. 35.

In den Pinnulae erleidet der Genitalstrang bei allen von mir zerlegten Tieren keine Veränderung; höchstens wird das Lumen des Genitalgefässes noch mehr reduziert, da die Genitalröhre zuweilen etwas an Umfang zunimmt. Eine Ausbauchung oder Anschwellung der Pinnulae bestand weder innerlich noch äusserlich. Leider ist es mir auch bisher trotz zahlreicher, in jeder Richtung geführter Schnitte nicht gelungen, präformierte Öffnungen oder Anlagen zu solchen für den Austritt von Geschlechtsprodukten zu finden. So blieb mir die Art und Weise der Eiablage von *Pentacrinus* fraglich. In den Pinnulae durchzieht der Genitalstrang in der Regel nur die ersten zwei oder drei, seltener vier proximalen Glieder, und zwar besitzt er im ersten und zweiten Gliede im

allgemeinen den grössten Durchmesser. Dann verjüngt er sich stetig und läuft bei männlichen Tieren in eine Spitze aus, die durch Bindegewebe von den Wänden des Genitalkanals her gehalten wird. Bei weiblichen Exemplaren ist das Ende des Stranges mehr abgerundet und gleichfalls von Bindegewebe gehalten.

In den Armen scheint der Genitalstrang meist nur bis zum acht- oder zwölftletzten Brachiale zu reichen. Genaues hierüber ist schwer festzustellen, da die letzten Brachialia meist abgebrochen sind; der Strang findet seinen Abschluss wie in den Pinnulae.

Unterziehen wir nunmehr die Generationsorgane der männlichen Tiere einer näheren Betrachtung und werfen wir nochmals einen Blick auf die Fig. 18 und 19, welche einen Längs- und einen Querschnitt durch einen Teil eines Armes zeigen, der männliche Keimzellen enthält. Auch hier wird das Lumen des die Genitalröhre umhüllenden Genitalgefässes nur ventralwärts freigelassen; fast drei Viertel des letzteren werden durch die Genitalröhre ausgefüllt. Der Durchmesser derselben schwankt in den Armen zwischen 0,065 und 0,112 mm. Die Grösse der männlichen Keimzellen beträgt 0,002 bis 0,004 mm. Sie zeigen in jüngeren Stadien in der Mitte einen ziemlich grossen Kern, der sich bedeutend dunkler färbt, wie das ihn umgebende Plasma. Die bereits weiter entwickelten Spermatozoen waren nur als runde dunkle Körner sichtbar, an denen ich fadenförmige Fortsätze nicht bemerken konnte.

Leistenförmige Vorsprünge der inneren Fläche der männlichen Genitalröhre, die bei *Pentacrinus decorus* gleich der weiblichen nur von einer dünnen Bindegewebslamelle ohne Innenepithel gebildet wird, sind nicht vorhanden. Ludwig (18) S. 36 schildert diese Vorsprünge in den Testikeln der Pinnulae von *Antedon eschrichti* und illustriert die Beschreibung durch die Fig. 48 und 49 auf Taf. XVII.

Wenig abweichend hiervon beschreibt Ed. Perrier (21) den Bau der männlichen Genitalröhren in den Pinnulae von *Antedon rosaceus*: " . . . Le testicule lui même est formé d'un grand nombre de colonnes de cellules, colonnes cylindriques, ou légèrement renflées en massue, et dont la base est presque exactement circulaire. Ces colonnes résultent d'une invagination en doigt de gant de l'épithélium testiculaire. . . ."

Bei *Pentacrinus* ist, wie gesagt, der Bau der männlichen Generationsorgane sowohl in den Armen wie in den Pinnulae dem der weiblichen gleich. Die männlichen Keimzellen liegen dichtgedrängt regellos rings neben der einfach gebauten Wandung und lassen nur zuweilen in der Mitte der Genitalröhre ein kleineres oder grösseres Lumen frei, wie aus Fig. 19 ersichtlich ist.

2. Der Genitalstrang beim Übergang der Arme in den Kelch.

Gehen wir nun zu den Teilen des Armes über, welche proximal, d. h. näher am Kelch gelegen sind, wie die eben geschilderten Partien, also etwa zu den ersten Brachialia. Im allgemeinen trifft man hier in der Genitalröhre kleine Strecken ohne Keimzellen an; die beiden Schläuche haben sich etwas verengt. Ein Ei in der Grösse von rund 0,09 mm füllt fast das gesamte Lumen aus. Je mehr wir uns weiterhin der Scheibe zu bewegen, um so grösser werden die Strecken, auf denen keine Keimzellen vorhanden sind; kommen solche vor, so besitzen sie immerhin noch eine Grösse von 0,045 bis 0,055 mm und mehr. Die innere Weite des Genitalgefässes beträgt hier durchschnittlich 0,006 mm.

Beim Übergang in die Kelchscheibe verengt sich wie bei *Antedon* der ganze Genitalkanal erheblich. Der in ihm befindliche Doppelschlauch kann sich seitlich nur wenig ausdehnen. Gezwungenermassen nehmen die Genitalzellen eine länglich gestreckte Form an: 0,04 · 0,0495 mm, 0,036 · 0,048 mm, Keimbläschen 0,021 bzw. 0,02 mm. Seltsamerweise fand ich in den axillaren Gliedern fast nie Geschlechtsprodukte, vielmehr nur die leeren sich gabelnden Stränge. Dagegen waren kurz vor und nach der Teilungsstelle häufig dichtgedrängt Keimzellen vorhanden.

Der besseren Übersicht wegen möge hier eine Tabelle folgen. Die Messungen sind an Teilen eines weiblichen Tieres angestellt und lassen sich verhältnismässig auf die Mehrzahl der von mir untersuchten Tiere übertragen.

3. Verlauf und Bau der Genitalstränge im Kelch.

Zur Orientierung verweise ich auf die Wiedergabe eines günstig gelegenen Horizontalschnittes durch den Kelch, Fig. 22. Er zeigt den Verlauf der Generationsorgane in der oberen Kelchhälfte, zwischen dem Darm und dem ventralen Integument. Im Übergang zu einem Arme ist der Genitalstrang schief getroffen; seine Fortsetzung findet er im Kelch in einem weitverzweigten System gleichgebauter Röhren. Während bei *Antedon* die Genitalstränge nach der Beschreibung Hamanns, (13) S. 119 ein unregelmässiges Pentagon bilden, das im Kelch in einiger Entfernung das drüsige Organ umlagert, Perrier (21) S. 24 ff. und Fig. 162 dieselben aber als einzelne Stränge unmittelbar aus dem drüsigen Organ herleitet und zu den Armen ziehen lässt, fand Russo (24) im oberen Teile der Scheibe ein förmliches Netzwerk von Genitalsträngen, wie er Fig. 39, Taf. II, von einem erwachsenen *Antedon* darstellt. Mit letzterem übereinstimmend, fand ich bei *Pentacrinus* ebenfalls ein sehr

Grösse in mm:

Teil des Armes	Keimzellen	Keimblaschen	Keimfleck	Genitalröhre	Genitalgefäss
Übergang in der Kelch	0,0419 0,045 0,0294 0,031 0,0286	0,021 0,025 0,0128 0,0136 0,0147	etwa 0,004	Häufig Abschnitte ohne Eier	Durchmesser bis 0.06 wo Keimzellen vorh.; 0,024 wo keine vorhanden.
Brachialia I und II	0,081 0,0748 0,0683 0,0954	0,0354 0,0283 0,027 0,0413	0,0074 0,008 0,0071 0,0085	Kleine Strecken ohne Eier; ein Ei füllt das Lumen	
Brachialia IV bis VII	0,0968 0,1025 0,104 0,0973	0,0397 0,0412 0,064 0,0341	0,008 0,0092 0,00893 0,0084	Zwei Eier nebeneinander füllen das Lumen	Kaum kenntlich; bildet rings einen Kanal von 0,003 Weite.
Brachialia VIII bis X	0,0958 0,099 0,102 0,113 0,1096 0,1074	0,0326 0,031 0,0331 0,0382 0,042 0,0416	0,0086 0,009 0,0092 0,009 0,0094 0,00938	Zwei bis drei grosse Eier mit einigen sehr kleinen das Lumen füllend	Freier Teil ventralwärts gelegen; sein Durchmesser bis 0,035.
Brachialia höherer Ordnung	0,118 0,125 0,1184 0.108 0.107 0,136 0,124 0,1168	0,0291 0,034 0,0286 0,0241 0,032 0,0276 0,0315 0,0334	0,011 0,0103 0,01 0,009 0,009 0,0134 0,0087 0,0107	Zwischendurch einzelne sehr kleine Keimzellen vorhanden	Durchmesser bis 0,028.

stark verzweigtes Netzwerk, welches weite Maschen besass. Dasselbe durchzieht Bindegewebslücken, welche die Fortsetzung des Genitalkanals im Kelche zu bilden scheinen, und wird stellenweise eng von Bindegewebe umsponnen und begleitet.

Die Stränge des Netzwerks setzen sich ebenfalls aus zwei ineinander geschobenen Röhren zusammen. Die Wandung der äusseren Röhre, d. h. des Genitalgefässes, ist mit einem gleichen Epithel versehen, wie in den Armen. Unter diesem Epithel befindet sich wiederum eine Bindegewebslage von wechselnder Feinheit, in der man auf vereinzelte Kerne trifft. Ein eigentliches Endothel ist nicht vorhanden. Die Wandung der Genitalröhre selbst ist nur an sehr günstigen Stellen wahrzunehmen; sie besteht aus einer dünnen bindegewebigen Lamelle mit spärlichen Kernen. Perrier (21) stellt einen Querschnitt durch die Genitalröhre im Kelch von *Antedon* in seiner Fig. 144, Pl. XVII, dar. Die dort mit *a* bezeichnete Membran ist auch bei *Pentacrinus* vorhanden; es fehlt aber hier ein Innenepithel, welchem Perrier den Namen "epithelium genital" beilegt, und aus dem er die Keimzellen hervorgehen lässt.

Der Durchmesser der das Netzwerk bildenden Doppelröhren schwankt erheblich; dieselben sind teils nur schwach, teils sehr stark entwickelt. Unter andern fand ich als Durchmesser für:

Genitalgefäss	Genitalröhre
0,0571 mm	0,042 mm
0,0738 "	0,0573 "
0,025 "	? "
0,0416 "	0,023 "
0,0176 "	? "
0,0981 "	? "
0,101 "	0,096 "
0,127 "	0,0983 "

Man ersieht daraus, dass die Genitalstränge nach dem Übergang in die Kelchscheibe wieder im allgemeinen ganz bedeutend an Stärke zunehmen. Von *Antedon* hingegen berichtet Hamann (13) S. 119, dass der Genitalschlauch im Kelch einen bedeutend geringeren Durchmesser als in den Armen besitze; er bestimmt die Dicke desselben auf 0,02 mm, die der eigentlichen Genitalröhre auf 0,01 mm.

Als Inhalt des Genitalgefässes fand ich helles, äusserst feines Gerinnsel, das zuweilen eine schwache Färbung annahm, sowie gelbliche, meist grobkörnige Massen, an denen eine zellige Struktur nicht erkennbar war. Mitunter fanden sich wohlerhaltene Lymphkörperchen, auf die ich gleich zurückkommen werde. Die gelben Elemente trifft man auch in den

intervisceralen Blutgefässen an. Cuénot (10) S. 425 hält sie: "pour des amibocytes migrants, . . . chargés d'apporter des produits de réserve dans les divers organs." Auch ich möchte die gelben Massen als Reservestoffe ansprechen, kann aber nicht wohl eigentliche Wanderzellen in ihnen erkennen.

Bei Cuénot, Études sur le sang et les glandes lymphatiques (11) werden die Lymphkörperchen der Echinodermen einer eingehenden Betrachtung unterzogen, S. 613–641. Von Crinoiden hat Cuénot anscheinend nur *Antedon* untersucht und berichtet hierüber: "Les plus nombreux (pl. XVIII, fig. 19) sont des amibocytes assez petits, 11 μ, . . . émettant de courts pseudopodes; ils sont donc assez différents de ceux des Oursins et des Astéries si bien caracterisés par le développement de leurs pseudopodes." Bei *Pentacrinus* senden die 0,022–0,03 mm grossen Lymphkörperchen dagegen im allgemeinen sehr lange Pseudopodien aus, wie Fig. 21 zeigt. Die Körper selbst enthalten eine kleinere oder grössere Anzahl unregelmässiger Körnchen und ein blasiges Gebilde. Mit den eben erwähnten gelben Elementen haben sie keine Ähnlichkeit. In der Länge der Pseudopodien finde ich zwischen *Pentacrinus* einerseits und den *Echinoidea* und *Asteroidea* anderseits nicht den geringsten Unterschied. Bei *Pentacrinus* scheinen sich die Pseudopodien stetig zu verjüngen und laufen in eine Spitze aus, während sie bei den eben erwähnten Klassen ihre Breite beibehalten, eine Differenz, die aber auch durch die Konservation hervorgerufen sein kann, da mir nur in Alkohol konserviertes Material zur Verfügung stand. Verbindungsbrücken zwischen zwei oder drei benachbarten Pseudopodien fand ich bei *Pentacrinus* nicht vor, während solche nach Cuénot, Pl. XVIII, Fig. 7 und 8, bei *Echinoidea* und *Asteroidea* häufig sind.

Die eigentliche Genitalröhre endlich birgt auch im Kelch Genitalzellen der verschiedensten Grösse. Fig. 20 gibt das Bild eines sehr stark vergrösserten Längsschnittes durch einen Teil eines weiblichen Genitalstranges. In Fig. 22 erkennt man der geringen Vegrösserung wegen nur die bereits weiter vorgeschrittenen Ureier als dunkle Körper, mit deutlich sich abhebendem hellerem Keimbläschen.

Auffallend sind die beträchtlichen Grössenunterschiede der im Kelch befindlichen Eizellen. Oft findet sich nahe beieinander jedes Wachstumstadium vertreten. Neben kleinen Zellen von 0,015 bis 0,017 mm Durchmesser, welche in Form und Aussehen genau mit den von Hamann (13) Taf. XII, Fig. 15 wiedergegebenen Plasmawanderzellen von *Antedon eschrichti* übereinstimmen, trifft man Eizellen, welche sich bereits sehr weit entwickelt haben und deren Durchmesser bis 0,11 mm beträgt.

Eine solche Zelle füllt in der Breite ein Gefäss fast bis zum Platzen aus. In engen Gefässen nehmen demgemäss die grösseren Eizellen eine sehr langgestreckte Gestalt an. Folgende Messungreihe möge die Verhältnisse genauer illustrieren:

Grösse der:	Keimzellen	Keimbläschen	Keimflecke	
	0,016	0,009	?	mm
	0,024	0,01	?	"
	0,0216	0,098	?	"
	0,0283	0,0113	0,001	"
	0,0641	0,0246	0,0062	"
	0,1018	0,0283	0,0108	"
	0,102	0,031	0,0109	"
	0,113	0,0462	0,0098	"
	0,098 . 0,0284	0,027	0,0079	"
	0,0475 . 0,19	0,045 . 0,019	0,00953	"
	0,04 . 0,11	0,031	0,00824	"

Verfolgen wir die Züge des Netzwerks der Genitalstränge zentralwärts, so gelangen wir schliesslich in die Nähe der Mundöffnung. Dort setzen sich die Genitalgefasse mit dem Geflecht der labialen Blutgefässe in Verbindung. Einzelne Ausläufer des letzteren treten an die Genitalgefässe heran und anastomosieren mit denselben, wie ich mit grosser Sicherheit aussprechen kann. Weiterhin umziehen die Genitalgefasse den Schlund in unmittelbarer Nähe und treffen dort mit Teilen des bindegewebigen Gefässes zusammen, welches, wie oben S. 19 erwähnt, aus der Mitte des dem drüsigen Organ angelagerten Zellkomplexes in der Richtung auf den Schlund hinführt. Gleich neben dem labialen Blutgefässgeflecht finden sich in der Genitalrohre mitunter schon weit entwickelte Eizellen von 0,043 bis 0,062 mm Grösse, an denen Keimbläschen und Keimfleck leicht kenntlich sind. Der günstige Umstand, dass die Genitalfässe ziemlich umfangreich sind und bereits grosse Eizellen enthalten, erleichtert die Feststellung ihres Verlaufs bei *Pentacrinus* bedeutend.

Nach dem Gesagten möchte ich nun wiederholen, dass ich die Zellen des fraglichen Komplexes für Plasmawanderzellen halte, welche sich loslösen, durch das um den Schlund ziehende Rohr zum labialen Blutgefässgeflecht hinwandern, um sich endlich in den Strängen der Scheibe und der Arme und Pinnulae zu heranwachsenden Ei- bzw. Samenzellen zu entwickeln. Weiterhin scheint mir für diese Ansicht vornehmlich folgendes zu sprechen.

In den Genitalröhren von *Antedon* fand Ludwig (18) S. 31 und Taf. XV, Fig. 15, in den Armen einen inneren Wandbelag von nur 0,0075–

0,0085 mm grossen Zellen, aus denen sich erst später in den Pinnulae die Eier entwickelten. Ausführlicher, aber im wesentlichen mit Ludwig übereinstimmend, beschrieb Hamann (13) S. 118, die in den Genitalröhren von *Antedon* vorgefundenen Zellen. A. Lang (16) S. 1089 und 1090, Fig. 776, spricht von einer Wandverdickung, einer Leiste, von der aus sich stets neue Keimzellen bilden. Perrier (21) S. 51 endlich nennt den Innenbelag der Genitalröhren: l'épithélium producteur des œufs, bzw. l'épithélium testiculaire.

Dagegen haben wir bei der Besprechung der Genitalröhren von *Pentacrinus decorus* gesehen, dass dort weder ein innerer Zellbelag, ein Epithel, noch eine Leiste vorhanden ist, aus welchen sich Keimzellen bilden könnten. Vielmehr fanden wir die aus einer dünnen Lamelle gebildete Genitalröhre des Armes von weit entwickelten Ei- oder Samenzellen erfüllt.

Hamann sprach (14) S. 83 zuerst aus: Er betrachte die Zellen in der Genitalröhre nicht als festsitzende Epithelzellen, sondern als Wanderzellen, welch in die Pinnulae einwandern, um dort zu reifen. Weiterhin sagt er: " Die Geschlechtsprodukte entstehen an besonderen Stellen der Genitalröhren aus Urkeimzellen", ohne aber solche Stellen des Näheren zu bezeichnen. — Dass die Keimzellen in der Tat Wanderzellen sind, dafür scheint mir *Pentacrinus decorus* ein gutes Beispiel zu liefern. Schon aus der veränderlichen Form der jüngeren Keimzellen kann man auf eine amöboide Fortbewegung schliessen; bereits ziemlich weit in der Entwicklung vorgeschrittene Keimzellen zeigen in hohem Grade die Fähigkeit, sich sehr engen Röhren anzupassen, wie wir weiter oben gesehen haben.

Da wir nun bereits im Kelch von *Pentacrinus* eine grosse Anzahl weit entwickelter Eizellen fanden, und eine Epithel, aus dem sich Keimzellen bilden und loslösen könnten, nicht vorhanden ist, haben wir meiner Meinung nach die Ursprungsstelle der Urkeimzellen im Kelch zu suchen und kommen naturgemäss auf den dem drüsigen Organ angelagerten Komplex zurück, dessen Zellen die grösste Ähnlichkeit mit Plasmawanderzellen, bzw. Urkeimzellen besitzen (vgl. Fig. 16 u. 20).

Es erübrigt noch der Versuch, Klarheit über das Verhältnis zwischen dem drüsigen Organ und dem ihm angelagerten Zellkomplex zu erhalten. Früher sprach man das drüsige Organ allgemein als Mittelpunkt des Gefässsystems an (Ludwig, Greef u. a. m.), neuerdings wird es als Genitalstolo bezeichnet (Perrier, Hamann).

Hamann (13) S. 119 verfolgte beim erwachsenen *Antedon* die Genitalstränge von den Armen her in die Scheibe bis zur unmittelbaren Nähe

des drüsigen Organs, ohne aber einen Zusammenhang mit diesem finden zu können.

Perrier (21) kam auf Grund entwicklungsgeschichtlicher Forschungen zuerst zu der Ansicht, das drüsige Organ selbst sei der einzige Ausgangspunkt der Generationsorgane. Von ihm aus lässt er die Genitalstränge ihren Ursprung nehmen und zu den Armen hinziehen. Er legt ihm daher den Namen "stolon génital" bei und erklärt es als homolog der "glande ovoide" der Asteriden und Echiniden (S. 211).

Zu einem hiervon abweichenden Ergebnis kommt A. Russo, der sehr genaue, ebenfalls der Hauptsache nach entwicklungsgeschichtliche Studien an *Antedon* gemacht hat. Er beobachtete das Auftreten von Genitalzellen an verschiedenen Körperteilen der jungen Larve, und berichtet darüber (24) S. 11 ff.: "Sul principio alcune cellule celomiche, che formano una delle due pareti del mesentere, . . . s'ingrandiscono molto, aumentando anche di numero come si vede in *g* delle fig. 15, 23, 36, 42. In tal modo si forma un cumulo di cellule caratteristiche per le dimensioni molto grandi, e per il loro nucleo grosso e rotondo, che formano il primo accenno della gonade." Dieser von Russo Gonade genannte Komplex liegt nach seiner Schilderung in der Nähe des Oesophagus, etwa in der Mitte des Interradius *CD*.

Fast gleichzeitig mit dieser Bildung sah Russo in der Nähe des gekammerten Organs den oben genannten ähnliche Zellelemente entstehen, welche sich lebhaft vermehren und später das drüsige Organ, "l'organo assile," bilden.

Schliesslich fährt er dann weiter unten fort: "In corrispondenza dell' esofago, ben presto nella larva alquanto avanzato nello sviluppo, dopo che l'organo assile si è constituito, si differenzia dalle cellule peritoneali un nuovo gruppo di elementi sessuali. Il processo, con cui questi si formano è chiaramente visibile nella fig. 25, dove alcune cellule celomiche sono molto ingrossate e sporgenti nella cavità generale, in modo da formare una gemma. Esse, proliferando si mettono in rapporto con l'organo assile mentre in seguito formano attorno l'esofago una serie di cordoni genitali cavi, aventi diverse dimensioni. . . . Dai cordoni periesofagei emanano però molti cordoni cellulari pieni, i quali si anastomizzano fra di loro formando un intreccio, come si vede nella fig. 40, ricavata da una sezione orizzontale di grosso *Antedon*."

Die von Russo zuerst erwähnte Zellgruppe im Interradius *CD* reduzierte sich später und verschwand. Die zuletzt genannte Gruppe dagegen blieb bestehen und trat an das drüsige Organ heran. Aus ihr wird der eigentliche Bildungsherd der Urkeimzellen.

Meine an *Pentacrinus* gemachten Beobachtungen stehen mit denen Russos in vollem Einklang. Es ist unschwer zu erkennen, dass der Komplex der Urkeimzellen nicht aus dem drüsigen Organ hervorgegangen ist; es gelang mir nicht einmal mit Gewissheit nachzuweisen, dass die Schläuche des letzteren sich zu dem Komplex hin öffnen, obwohl ich dies für wahrscheinlich halte; aus meinen Schnitten liess sich bisher nur eine Randanlagerung und Verbindung unter einem Epithel erkennen. Die Zellelemente beider Organe sind sehr voneinander verschieden und deutlich gegeneinander abgegrenzt.

Denkt man sich den von mir bei *Pentacrinus* gefundenen Zellkomplex sehr verkleinert, so wurde er eine Gemme bilden, wie Russo sie von der jungen *Antedon*-Larve beschreibt und in seiner Fig. 25 darstellt. Auch die bei meinen erwachsenen Tieren noch vorhandene Verbindung mit dem Cölomepithel des Schlundes stimmt mit den von Russo gemachten Beobachtungen überein.

Zuerst möchte es scheinen, dass die Form der Komplexe einen Unterschied bedinge, indem bei *Antedon* ein dicker Strang vorhanden ist, welcher sich dem drüsigen Organ eng anschmiegt, während es bei *Pentacrinus* zur Ausbildung einer Scheibe kommt. Bei näherer Untersuchung jedoch ergibt sich aus dem Verhalten der Komplexe der Urkeimzellen bei *Pentacrinus decorus*, bei dem pentacrinoiden Larvenstadium von *Antedon* und bei dem erwachsenen *Antedon* eine interessante, phylogenetische Beziehung. *Pentacrinus* behalt zeitlebens die Gemmenform des Komplexes bei, welche bei *Antedon* nur im pentacrinoiden Stadium vorübergehend vorhanden ist, während der erwachsene *Antedon* bereits eine höhere Modifikation dieser Form aufweist, einen weiteren Fortschritt phylogenetischer Entwicklung darstellt.

Die Homologie der "glande ovoide" mit dem drüsigen Organ allein halte ich nicht fur vollständig; vielmehr kommt erst durch die Vereinigung des drüsigen Organs mit dem eigentlichen Bildungsherd der Urkeimzellen ein Komplex zustande, der mir in seiner Gesamtheit der "glande ovoide" der Asteriden und Echiniden gleichwertig scheint.

Zusammenfassung.

I. Antiambulacrales Nervensystem.

Ausser dem bereits früher bekannten Ring in den Radialia, fanden wir schon in den Basalia Connective, welche die vom Zentralorgan ausgehenden Stränge paarweise verbanden. Die Paare verlaufen bis zu dem in den Radialia befindlichen Ring getrennt parallel und vereinigen

sich erst dort wieder. Das Chiasma ist einfacher wie bei *Antedon* gebaut. In jedem axillaren Gliede ist ein Chiasma vorhanden.

2. Gekammertes Organ.

Das gekammerte Organ hat keine Fortsetzungen nach oben; seine fünf Kammern enden blind geschlossen. Nach unten sendet es Ausläufer in den Stiel, von denen in den Nodien die Cirrengefässe ausgehen. Gebildet wird es von einer dünnen Bindegewebslage, die mit einem deutlichen Endothel versehen ist. Seine sämtlichen Teile enthalten als charakteristiches Merkmal dunkle Körner, deren Natur uns zweifelhaft blieb. Im oberen Teil des gekammerten Organs verlaufen im Innern von Wand zu Wand ziehend schwache bindegewebige Stränge, die frei von Kalkbildungen sind.

3. Drüsiges Organ.

Vom drusigen Organ aus geht in den Stiel der Achsenstrang, der aus einer einfachen Röhre mit sehr engem Lumen besteht. Die ihn bildenden Zellen besitzen Ähnlichkeit mit denen des drüsigen Organs.

Im Kelch wird das drüsige Organ von einer sehr grossen Anzahl von Schläuchen gebildet, zwischen denen schwache Bindegewebsfasern vorkommen. Ob alle Schläuche untereinander in Verbindung stehen, liess sich nicht feststellen. Die Gesamtheit der Schläuche lässt annähernd in ihrer Mitte ein kleines Lumen frei, gegen das sie durch Cölomepithel abgegrenzt ist. Im unteren Teil des drüsigen Organs wird das Lumen von einzelnen Bindegewebssträngen durchzogen. Ich spreche es als abgekapselten Teil der Leibeshöhle an. Dem oberen Teil des drüsigen Organs ist ein umfangreiches Zellpolster angelagert. Dasselbe bildet mit dem drüsigen Organ einen oben offenen Sack. In diesen treten vom labialen Blutgefässgeflecht her zahlreiche Gefässe ein.

Ein direkter Zusammenhang der Schläuche des drüsigen Organs mit Blutgefässen war nicht nachweisbar, wohl aber das Eintreten der letzteren unter das Epithel, welches das drüsige Organ umhüllt.

4. Die Geschlechtsorgane.

Den Ausgangspunkt der Urkeimzellen bildet der dem drüsigen Organ angelagerte Komplex. Von diesem aus geht ein Strang, welcher den Schlund in unmittelbarer Nähe umzieht, zum labialen Gefässgeflecht hin. Durch Verzweigung kommt unterhalb des Integuments der Kelchdecke ein umfangreiches Netzwerk von Genitalstrangen zustande. Von dem Netzwerk aus ziehen Ausläufer durch die Arme zu den Pinnulae. Die

Stränge und Ausläufer bilden Doppelröhren. Die äussere Röhre, das Genitalgefäss, ist ein Blutgefäss; die innere Röhre besteht nur aus einer feinen bindegewebigen Lamelle und enthält Geschlechtsprodukte. Die Genitalröhre hat kein Innenepithel.

Das Zellpolster, von welchem die Plasmawanderzellen ausgehen, um sich bald zu Ei- oder Samenzellen zu entwickeln, wird von Blutgefässen umzogen und durchlaufen. Es ist meiner Meinung nach nicht wohl möglich, Blutgefässsystem und Generationsorgane scharf zu sondern. Beide sind aufs engste miteinander verbunden. Ob sich vielleicht die Generationsorgane überhaupt als Blutgefässe betrachten lassen, worauf Ludwig (18) S. 89 hinweist, darüber könnte ich mir kein volles Urteil bilden, da mir nur ausgewachsene Tiere zur Verfügung standen.

Bonn, im Dezember 1904.

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ERKLÄRUNG DER ABBILDUNGEN.

Die folgenden Buchstaben gelten für alle Figuren:

a, Achenstrang;
bg, Bindegewebe;
cep, Cölomepithel;
co, Centralorgan;
d, Darm;
dep, Darmepithel;
dn, dorsaler Nervenstrang;
do, drüsiges Organ;
G, Bildungsstätte der Urkeimzellen;
go, gekammertes Organ;
gz, Ganglienzelle;
kgr, Kalkgrundsubstanz;
mo, Mundöffnung;
nr, Nervenring in den Radialia;
oe, Oesophagus;
sy, Syzgie.

TAFEL I.

Fig. 1. Längsschnitt durch den Kelch von *Pentacrinus decorus*. Kopie nach P. H. Carpenter (5) Pl. LXII, $^1/_2$ mal verkleinert und etwas umgeändert.

Erklärung der Farben: Nervensysteme gelb; Blutgefässe roth; Wassergefässsystem grün; drüsiges Organ schwarz; Generationsorgane grauschwarz. *B*, Basale; *R*, Radiale; C_1, Costale; D_1, Distichale *I*; *ap*, ambulacrale Platten; *kp*, Kelchporen; *sap*, subambulacrale Platten; *abc*, ambulacrales Nervensystem; *st*, Steinkanal; *lbg*, labiales Blutgefässgeflecht; *ib*, intervisceràles Blutgefäss; *wg*, Wassergefäss; *r*, Rectum; *gs*, Genitalstrang.

Fig. 2. Tangentialer Langsschnitt durch die untersten Armglieder, um die Chiasmata, *ch I*, *II* und *III* zur Anschauung zu bringen. *R*, Radiale; *C*, Costale; *D*, Distichale; *P*, Palmare; *B*, Brachiale; *dst*, Dorsalstrang.

Fig. 3. Querschnitt durch ein Nodium des Stieles, so dass die von den Fortsetzungen des gekammerten Organs *fg* ausgehenden Cirrengefässe *cg* getroffen sind. *ep*, Epithel des gekammerten Organs; *n*, Nervenschicht; n_1, deren periphérische zu den Cirrengefässen hinziehende Fasern; *k*, dunkle Körner. Zeiss, Obj. E, Oc. 2.

Fig. 4. Querschnitt durch ein Cirrengefäss mit der umgebenden Nervenschicht *n* im Stiel. *cg*, Lumen des Gefässes; *sc*, Septum. Zeiss, Obj. C, Oc. 2.

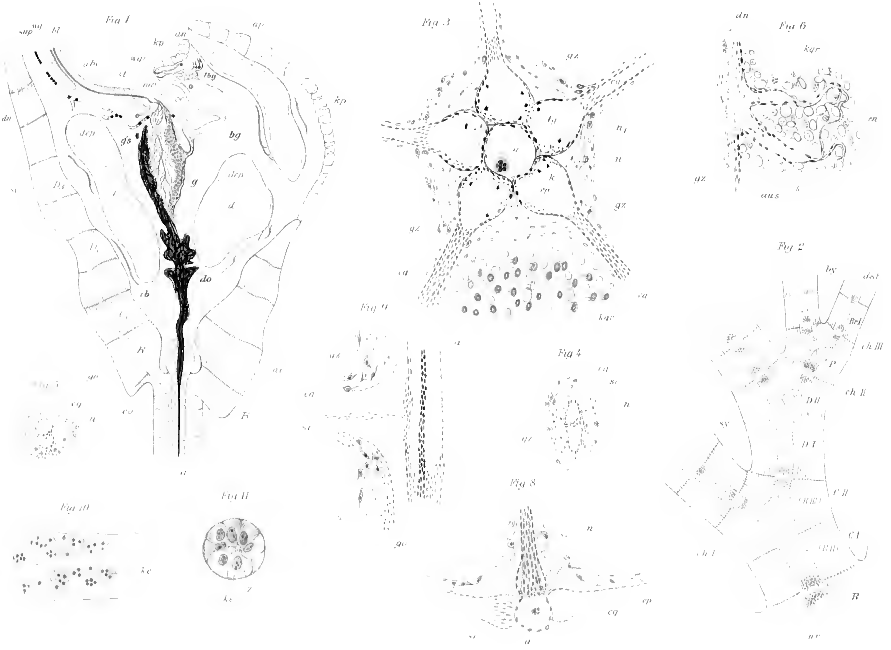
Fig. 5. Querschnitt durch ein Cirrengefäss, nachdem dasselbe in den Cirrus eintrat. Die Nervenschicht *n* hat sich auf die beiden Seiten gezogen. Zeiss, Obj. C, Oc. 2.

Fig. 6. Zwei Ausläufer, *aus*, des dorsalen Armnervenstranges *dn*, deren feinste Enden, *en*, in der Kalkgrundsubstanz verlaufen. *k*, begleitende Kerne. Zeiss, Obj. C, Oc. 2.

Fig. 8. Teil eines Querschnittes durch ein Nodium des Stieles in Höhe der in die Cirrengefässe ziehenden Septen *sc*. *n*, Nervenschicht und deren peripherische Fasern; *ep*, Epithel des Cirrengefässes. Zeiss, Obj. C, Oc. 2.

Fig. 9. Teil eines Längsschnittes durch ein Nodium. *sp*, Septum; *cg*, Beginn eines Cirrengefässes; *n*, Nervenfaserschicht; *go*, Fortsetzung des gekammerten Organs. Zeiss, Obj. C, Oc. 3.

Fig. 10 u. 11. Längs- und Querschnitt durch den Achsenstrang. *z*, Zelle; *ke*, Kern. Fig. 10: Zeiss, homog. Immers. 1/18. Fig. 11: Zeiss, Obj. F, Oc. 4.



Pentacrinus decorus.

TAFEL II.

Fig. 7 *a–h*. Querschnitte zur Erläuterung des Verhältnisses des gekammerten Organs zum drüsigen Organ, bzw. Achsenstrang. Zeiss, Obj. C, Oc. 1.

Fig. 7 *a*: Querschnitt im Stiel. *n*, Nervenfaserschicht. Fig. 7 *b* u. *c*: In Höhe des Zentralorgans *co*. *k*, dunkle Körner. Fig. 7 *d*: In Höhe der Connective *cb* in den Basalia. *bg*, Bindegewebe der Leibeshöhle. Fig. 7 *e* u. *f*: In Höhe der Radialia. *ubg*, unverkalktes Bindegewebe; *k*, dunkle Körner. Fig. 7 *g*: Oberster Teil des gekammerten Organs; *ble*, blindes Ende einer Kammer. Fig. 7 *h*: Veranschaulichte Lage und Gestalt des drüsigen Organs *do* kurz nach dem Endigen des gekammerten Organs.

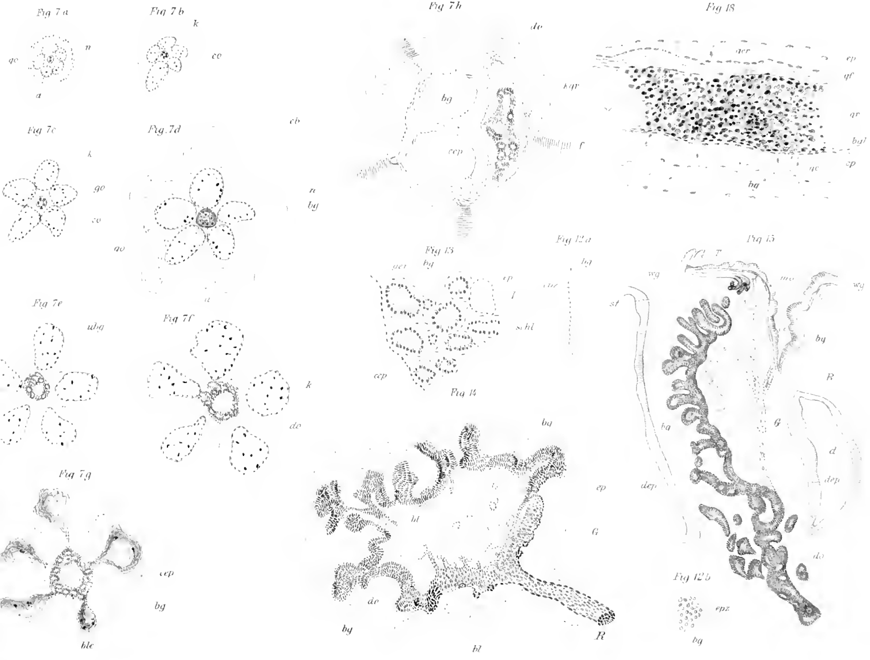
Fig. 12 *a* u. *b*. Wandung des gekammerten Organs. Fig. 12 *a* von der Seite, Fig. 12 *b* von der Flache aus gesehen. *epz*, Endothelzelle; *bg*, Bindegewebslamelle. Zeiss, Obj. E, Oc. 2.

Fig. 13. Stück eines Querschnittes durch die breiteste Stelle des drüsigen Organs. *ger*, Gerinnsel; *schl*, Schlauch; *bg*, Bindegewebsfasern; *L*, inneres Lumen; *ep*, dessen Epithel, welches dem Cölomepithel *cep* gleich ist. Zeiss, Obj. D, Oc. 2.

Fig. 14. Querschnitt durch den von drüsigem Organ und Bildungsherd der Urkeimzellen gebildeten Sack. *R*, zum Schlund hinführende Röhre; *bl*, Blutgefässe; *ep*, beide Organe unter sich vereinigendes Cölomepithel. Zeiss, Obj. C, Oc. 1.

Fig. 15. Längsschnitt durch den Sack. *wg*, Wassergefäss: *st*, Steinkanal; *T*. Tentakel; sonst wie in Fig. 14. Zeiss, Obj. B, Oc. 2.

Fig. 18. Längsschnitt durch den Genitalkanal *gc* eines männlichen Tieres. Die Genitalröhre *gr* ist mit Samenzellen erfüllt. *bgl*, Wand der Genitalröhre; *ep*, Epithel des Genitalgefässes *gf*; *ger*, Gerinnsel. Zeiss, Obj. C, Oc. 4.



Pentacrinus decorus.

TAFEL III.

FIG. 16. Teil des dem drüsigen Organ angelagerten Komplexes. *bl*, Blutgefässe; *plw*, Plasmawanderzellen; *cep*, Cölomepithel; *I*, Innenraum des Sackes; *A*, Leibeshöhle. Zeiss, Obj. F, Oc. 2.

FIG. 17. Teil eines Längsschnittes durch den Arm eines erwachsenen weiblichen Tieres. *gc*, Genitalkanal; *ger*, Gerinnsel; *ep*, Epithel des Genitalgefässes; *ez*, Eizelle; *kb*, Keimbläschen; *kf*, Keimfleck. Zeiss, Obj. AA, Oc. 2.

FIG. 19. Teil eines Querschnittes durch den Arm eines männlichen Tieres. *gc*, Genitalkanal; *ger*, Gerinnsel; *sz*, Samenzelle; *dc*, Dorsalkanal; *gef*, Genitalgefäss. Zeiss, Obj. F. Oc. 1.

FIG. 20. Genitalgefäss *gf* im Kelch längs durchschnitten. *gr*, Genitalröhre; *ep*, Epithel des Genitalgefasses; *ger*, Gerinnsel; *krm*, gelbe körnige Massen; *plw*, Plasmawanderzellen; *ez*, bereits weit entwickelte Eizelle. Zeiss, homog. Immersion 1/18.

FIG. 21 *a*. Lymphkörper *L* in einem Blutgefass *bl*. *ger*, Gerinnsel. Zeiss, Obj. D, Oc. 1.

FIG. 21 *b*. Lymphkörper, stärker vergrössert. *blg*, blasiges Gebilde; *ps*, Pseudopodien. Zeiss, Obj. F, Oc. 1.

FIG. 22. Teil des Netzwerkes der Genitalstränge im Kelch. Horizontalschnitt, zwischen Darm und Integument der Kelchdecke gelegen. *A*, Arm; *gk*, Genitalkanal; *gs*, Genitalstrang im Übergang zum Arme; *Ez*, weit entwickelte Eizellen; *gf*, Genitalstränge im Kelch; *kp*, Kelchporen. Zeiss, Obj C. Oc. 1.

Pentacrinus decorus.

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows: —

H. AUGENER. The Annelids of the "Blake."
C. HARTLAUB. The Comatulae of the "Blake," with 15 Plates.
H. LUDWIG. The Genus Pentacrinus.
A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
R. T. HILL. On the Geology of the Windward Islands.
W. McM. WOODWORTH. On the Bololo or Palolo of Fiji and Samoa.
AGASSIZ and WHITMAN. Pelagic Fishes. Part II., with 14 Plates.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows: —

A. AGASSIZ. The Pelagic Fauna.
" The Panamic Deep-Sea Fauna.
H. B. BIGELOW. The Siphonophores.
K. BRANDT. The Sagittae.
" The Thalassicolae.
W. R. COE. The Nemerteans.
W. H DALL. The Mollusks.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H J. HANSEN. The Cirripeds.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
J. P. McMURRICH. The Actinarians.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
M. P. A. TRAUSTEDT. The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.
W. McM. WOODWORTH. The Annelids.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to XLII., and also Vols. XLIV., XLV., and XLVII; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVIII., XXIX., XXXI., and XXXII.

Vols. XLIII., XLVI., XLVIII., XLIX., and L. of the BULLETIN, and Vols. XXV., XXVI., XXVII., XXX., XXXIII., XXXIV., and XXXV. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Professors and Assistants of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation: —

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, in charge of Professor N. S. Shaler.

These publications are issued in numbers at irregular intervals; one volume of the Bulletin (8vo) and half a volume of the Memoirs (4to) usually appear annually. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Librarian of the Museum of Comparative Zoölogy, Cambridge, Mass.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. XLVI. No. 11.

NEW PLAGIOSTOMIA.

By Samuel Garman.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

January, 1906.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer "Albatross," from October, 1904, to March, 1905, Lieutenant Commander L. M. Garrett, U. S. N., Commanding, published or in preparation:—

A. AGASSIZ. General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
F. E. BEDDARD. The Earthworms.
H. B. BIGELOW. The Medusae.
R. P. BIGELOW. The Stomatopods.
S. F. CLARKE. The Hydroids.
W. R. COE. The Nemerteans.
L. J. COLE. The Pycnogonida.
W. H. DALL. The Mollusks.
C. R. EASTMAN. The Sharks' Teeth.
B. W. EVERMANN. The Fishes.
W. G. FARLOW. The Algae.
S. GARMAN. The Reptiles.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. The Schizopods.
S. HENSHAW. The Insects.
W. E. HOYLE. The Cephalopods.
C. A. KOFOID. III.[3] The Protozoa.
P. KRÜMBACH. The Sagittae.
R. VON LENDENFELD. The Sponges.
H. LUDWIG. The Holothurians.
H. LUDWIG. The Starfishes.
H. LUDWIG. The Ophiurans.
J. P. McMURRICH. The Actinaria.
G. W. MÜLLER. The Ostracods.
JOHN MURRAY. The Bottom Specimens.
MARY J. RATHBUN. The Crustacea.
HARRIET RICHARDSON. II.[2] The Isopods.
W. E. RITTER. The Tunicates.
ALICE ROBERTSON. The Bryozoa.
B. L. ROBINSON. The Plants.
G. O. SARS. The Copepods.
H. R. SIMROTH. The Pteropods and Heteropods.
TH. STUDER. The Alcyonaria.
T. W. VAUGHAN. The Corals.
R. WOLTERECK. The Amphipods.
W. McM. WOODWORTH. The Annelids.

[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z., Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.

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January, 1906.

No. 11. — *New Plagiostomia.* By Samuel Garman.

The following are preliminaries of descriptions to be published with more details and with illustrations as soon as the necessary drawings are printed. All except two of the types described are from the collection of Alan Owston, Esq., taken at considerable depths off the Japanese coasts. Excepting one, of the Platosomia, all are Antacea. It may be added here that the name of this section of the Plagiostomia was formed by Rafinesque, 1815, from the Greek ῎Αντα (Latin *ante*), "before, in front," and 'Ακή or 'Ακίς (Latin *acies*), "a point," for a group comprised of sharks only; it contained no sturgeons, and the name was not, as has been asserted, made from "ἀνταкαῖος, sturgeon."

Hemigaleus pectoralis, sp. nov.

Outlines similar to those of the other species of this genus, strongly resembling those of *Mustelus canis* Mitch. Spiracle larger than the pores. Length of the preoral portion of the head greater than the width of the mouth. A moderate labial fold on each jaw. Teeth $\frac{3}{2}\frac{1}{5}$; upper oblique, wide, compressed, with coarse serrations in the notch on the outer side; lower with narrower and more erect cusps, becoming oblique toward the angles of the mouth; three series of smaller erect teeth at the symphysis, both above and below. Intestinal valve with a few transverse turns behind the longitudinal roll.

Grayish brown on the upper surfaces, olive in life, whitish below; fins dark, lighter on hind margins.

No. 847, Mus. Comp. Zoöl., from the "Aquarial Gardens," for which the collections were made off the coasts of Massachusetts and Rhode Island.

Parmaturus, gen. nov.

Differences in dentition, squamation, and in features of the head and tail, as compared with species of Catulus and Pristiurus, suggest the advisability of establishing a new genus, *Parmaturus*, to include the species immediately following, and also *Pristiurus eastmanni* J. & S., 1904, from off Izu, Japan, and *Catulus xaniurus* Gilb., 1891, off Lower California. Parmaturus is intermediate between Pristiurus and Catulus;

it is readily distinguished from the former by the features of the head, and from the latter by the caudal structure.

Parmaturus pilosus, sp. nov.

Head and snout shorter, nostrils closer to the mouth and spines more pilose than on *Pristiurus melastomus* Raf.; in these and other features somewhat nearer to Catulus, Scyllium. Dorsal fins subequal; origin of first very little backward of that of the ventral, base reaching little farther back than that of the latter; origin of second dorsal above the middle of the base of the anal and end of the base above that of the same fin. Teeth compressed; cusps in variable numbers, upper teeth commonly with six and lower most often with five. Labial folds equal, short, one fourth as long as the jaw. Nostrils wide, close to the mouth, equal in width to the internarial space or twice their distance from the edge of the mouth. Spiracles small, directly behind and distant one diameter from the eye. Gill clefts small, the hindmost two smallest, and situated above the base of the pectoral. Entire length of the pectoral fin hardly half the distance between its base and that of the ventral. Scales minute, velvety, each with a long, strong median cusp at each side of the base of which is a rudiment.

Uniform brown on back and fins, latter with black margins; light below, the lighter color extending up behind and above the pectoral fins.

No. 1107, Mus. Comp. Zoöl.

Hab. Lat. 34° 59′ N.; Lon. 139° 31′ E. "430 fathoms. Golden Hind."

Centrophorus, M. & H., 1837.

Present knowledge will hardly sanction acceptance of this genus as constituted by Günther, 1870. The species appear to group themselves in four distinct genera: (1) Centrophorus M. & H., 1837, of which *Squalus granulosus* Bl. & Sch., 1801, is the type, (2) Acanthidium Lowe, 1839, with the type species *A. calceus* Lowe, 1839, Deania J. & S., 1902, being a synonym, (3) Scymnodon B. & C., 1864, as represented by *S. ringens* B. & C., 1864, and (4) Centroscymnus B. & C., 1864, typified by *C. coelolepis* B. & C., 1864, and including the species of Zameus J. & F., 1903. Besides the new species added to these genera it is found that the affinities of *Squalus uyato* Raf., 1810 (*Spinax uyatus* Bonap., *Acanthias uyatus* M. & H.), are such as to remove it from the genus Acanthias, Squalus of later authors, and place it among the species of Centrophorus. All of these, with some differences of inclusion, are genera established before the publication of Günther's arrangement.

Centrophorus acus, sp. nov.

In general the outlines, dentition, and squamation resemble those of *C. granulosus* Bl. & Sch. Dorsal spines projecting beyond the skin. Teeth $\frac{36}{34}$, upper the more erect and narrower, lower with the cutting edge directed obliquely toward the

angle of the mouth; no median tooth in the lower jaw. Labial folds short, almost hidden in the groove. Distance between the inner edges of the nasal valves less than one third of the preoral length of the snout. First dorsal entirely in the forward half of the total length. Hinder angles of pectorals and ventrals slightly produced, longer on dorsals. Length of base of second dorsal less than three fourths of that of the first, not including the spine, contained three and two thirds times in the distance between the two spines. Ends of ventrals reaching backward of the spine of the second dorsal. Scales small, with stout stalks, and with several keels on the crown, the median one of which ends in a sharp cusp; lateral cusps rudimentary; keels less sharp toward the apex of the scale on the flanks.

Brown, nearly uniform, sprinkled with white single scales.

Distinguished from *C. tessellatus* by larger dorsals, less production of hind angles of dorsals, pectorals and ventrals, smaller sharper scales, smaller eyes, by dentition, and by a darker more uniform coloration.

No. 1049, Mus. Comp. Zoöl. of a total length of $32\frac{1}{4}$ inches.

Hab. Japan.

Centrophorus tessellatus, sp. nov.

Closely allied to *C. granulosus*, spines and scales similar. Teeth $\frac{4\,2}{3\,1}$, compressed, serrated on the basal portions of the cutting edges; upper with slender, sharp pointed cusps, more numerous and more erect, becoming more oblique toward the angles of the mouth; lower with oblique laterally directed cusp situated between two notches at the outer end of a serrated and arched portion of the cutting edge; a median tooth on the symphysis below; several series in function in the upper, and two in the lower. Labial folds extending less than half-way from angle to symphysis. Internarial distance equal to more than half the distance from the mouth. Spiracle large, superior, distant from the eye one and one half times the spiracular diameter, up and backward. Posterior angles of dorsals, pectorals, and ventrals much produced; length of base of first dorsal two fifths of the distance from the second, base of second three fourths of that of the first, end of pectoral reaching beyond the first dorsal spine; origin of first dorsal little backward of the axil of the pectoral; spine of second dorsal one third exposed; lower lobe of caudal well developed, end of caudal deep.

Light brownish on back and flanks, white below, a white band at margins of fins and gill clefts. Total length $34\frac{1}{2}$ inches.

No. 1031, Mus. Comp. Zoöl.

Hab. Lat. 35° N.; Lon. 139° 30′ E. 400 fathoms.

The shagreen of this shark, from specimens of moderate size, is no doubt as well adapted for covering the grip in the handles of sabres, swords, and other cutlery as that of *Centrophorus granulosus*.

Acanthidium Lowe, 1839.

Deania J. & S. 1902.

In the collection there are representatives of three species, neither of which is to be identified with the previously described species, *A. eglantina* of Japanese waters and *A. calceus* from the seas of Europe. They are

distinguished by differences in rostral lengths, in the teeth, in the shapes, positions, and lengths of the fins, in the scales, colors, etc. Generically they agree in the characters of the head, the greatly produced snout, large eyes, in nostrils, teeth, and spiracles, in the characters of the fins, and in general shapes. In the scales they are farther than *A. calceus* from Centrophorus, though like that species, their scales have slender peduncles and are erect, but each has three slender, distinct, and sharp cusps, without the web-shaped connections between their bases. On the inside of the valves the spiracles are provided with ridges like the gill laminae; in front of the valve there is a blind cavity or chamber, extending forward, like that of Centroscymnus, but of much less extent, or that of Centrophorus. The inner angles of dorsals and ventrals are much produced; those of the pectorals are short.

Acanthidium rostratum, sp. nov.

Rather more compressed in body than the other species of this genus. Dorsal spines strong, moderately exposed. Base of first dorsal in the forward half of the total length; inner angles of dorsals greatly, and those of the ventrals moderately produced; inner angle of pectoral little longer than outer, not produced in a point; base of first dorsal about two fifths of its distance from that of the second, base of second dorsal little more than that of the first; end of base of ventral nearly reaching a vertical from the second dorsal spine. Teeth $\frac{36}{30}$; upper with a notch at each side of the cusp, which latter is oblique and becomes more so toward the angles of the mouth; lower with cutting edges very oblique, approaching a horizontal. Upper labial folds hidden in the deep oblique grooves, half or more of each of which is in front of the angle; lower folds long, more than half as long as the jaw. Spiracle large, above the level of the eye and one diameter farther back; valves with small ridges; prevalvular chamber of moderate extent. Scales minute, with erect slender peduncles, and slender spine-like cusps, each of which is surmounted by a sharp longitudinal keel.

Light brownish or grayish brown, greenish or olive in life; lighter beneath; little darker on back, top of head or tail; whitish on hind and inner margins of dorsals, pectorals, and ventrals.

Total length, 34 inches.
No. 1047, Mus. Comp. Zoöl.
Hab. Suruga Gulf, Japan.

Acanthidium hystricosum, sp. nov.

Head nearly one fourth, tail one third, and caudal fin two ninths of the total length. Middle of the total length in the middle of the base of the first dorsal, including the spine. Teeth $\frac{33}{30}$, compressed; upper with narrow triangular cusps, which are triangular also in cross section, erect near the symphysis, little oblique toward the angles of the mouth; lower with cusps directed toward the corners of the mouth so much that each cutting edge is almost parallel with the edge of the jaw;

no median tooth below. Labial folds extending half the length, or a little more, of each jaw. Internarial distance two thirds of the distance from the end of the snout. Hinder angles of dorsals and ventrals much produced; pectorals subtruncate, with rounded angles, reaching half-way to a vertical from the first dorsal spine; base of second dorsal four fifths of that of the first dorsal, more than the total length of the ventral, fin reaching the caudal; end of ventral extending below more than half the base of the second dorsal. Spiracle large, distant one diameter from the orbit, above and slightly backward. Width of first gill cleft half the orbital length, hindmost clefts little wider and little nearer one another. Scales much larger than those of *A. rostratum*, pedunculate on a radiating base, with three slender cusps, harsh to the touch. Total length, $36\frac{1}{4}$ inches.

Dark brown, somewhat lighter below, black in the mouth, nostrils, orbits, gill clefts, spiracles, and on the edges of the fins.

No. 1130, Mus. Comp. Zoöl.
Hab. Sagami Bay, Japan.

Acanthidium aciculatum, sp. nov.

Elongate, slender, moderately compressed, caudal fin about one fifth of the total length. Teeth $\frac{30}{31}$, intermediate between those of the preceding and those of *Scymnodon ringens* B. & C., both upper and lower with more or less erect sharp pointed cusps, those on the upper jaw triangular and those on the lower bearing the cusp on the outer portion of the cutting edge. A few of those on the lower symphysis are nearly erect, the others become more and more oblique toward the angles. Internarial distance nearly one fourth as long as the snout. Spiracles large, near the eye, valves with ridges resembling the laminae of the gills. Dorsal spines large, strongly curved, that of the second dorsal much exposed; inner angle of pectoral rounded, not produced; length of the base of the second dorsal five sixths of that of the first, and the length of the base of the latter is three fifths of the distance between the bases of the two fins, or three eighths of the distance between the two spines. Scales very small, similar to those of *A. calceus*, but apparently having cusps more slender, sharper, and more erect; median cusp directed backward, lateral cusps extended out more toward the sides. Caudal fin deep, lower lobe not greatly developed. Total length, $34\frac{1}{2}$ inches. Uniform dark brown.

No. 1128, Mus. Comp. Zoöl.
Hab. Sagami Bay, Japan.

Centroscymnus Owstonii, sp. nov.

This species bears some likeness in form to *C. coelolepis;* it is distinguished by a snout that is longer, broader, and less pointed at the end, by nostrils that are farther apart, by a narrower mouth, by teeth on the lower jaw that are less nearly parallel with the edges of the mouth, by scales that are smaller and more keeled, and by fins of which the extremities of the dorsals are less pointed and the hinder ends of the bases of the ventrals are farther forward as compared with those of the second dorsal.

Dorsal spines hardly projecting beyond the skin. Scales pedunculate, pluricarinate on head, shoulders, and belly. Teeth $\frac{72}{30}$; upper lanceolate, more than twice as numerous as lower, in two groups at each side, cusps shaped like a spear-head, subtriangular in transsection, several rows in function; lower broad, compressed, cusps with a deep notch at the outer edge, apex raised, cutting edge rising obliquely toward the angles of the mouth, one row in function; no median tooth at the lower symphysis. Labial folds hidden in the deep, straight, oblique folds crossing the angles of the mouth; lower short, upper much longer and reaching half-way to the middle of the mouth, that is, a little farther than the groove. Nostrils widely separated, nearer to end of snout than to mouth. Spiracles medium, superior, one diameter backward and two diameters distant from the orbit, with a large antespiracular chamber, extending forward from the valve to a point above the posterior angle of the orbit, valve with folds on its inner side like gill lamellae. The lining of the prespiracular chamber is without shagreen and apparently is sensitive. Posterior margin of pectoral oblique, inner angle much shorter; base of second dorsal longer and fin higher than in first dorsal, hinder angle produced, base equal one fifth of its distance from the first dorsal base; end of pectoral not reaching to a vertical from the first dorsal spine; end of ventral base reaching a vertical from the spine of the second dorsal.

Uniform dark brown.

No. 1037, Mus. Comp. Zoöl. Total length, $31\frac{1}{4}$ inches.

Hab. Yenoura, Suruga Gulf, and Sagami Bay, Japan.

Named in honor of Alan Owston, Esq.

Pristis clavata, sp. nov.

The group of species of this genus containing *P. pectinatus* Lath., 1794, and *P. zysron* Blkr., 1852, is that in which the present form most naturally falls.

Rostral teeth in twenty-one pairs, not trenchant behind. Origin of the first dorsal one fourth of the length of its base farther backward than the origin of the ventral. Pectoral origin in advance of the first gill cleft nearly the width of the internarial space, or the length of the orbit; outer angle of pectoral fin blunt and bluntly rounded. Second dorsal smaller than first dorsal, length equal about three fifths of the length of the caudal fin, or one sixth shorter than first dorsal. Caudal fin obliquely truncated without an anterior lobe on the subcaudal portion. Total length, $24\frac{3}{8}$ inches.

No. 733, Mus. Comp. Zoöl.

Hab. "Queensland, Australia."

Distinguished from *Pristis pectinatus* by the smaller number of rostral teeth and the position of the first dorsal backward of the origins of the ventrals; from *P. zysron* by the smaller number of teeth in the saw, the more forward origin of the first dorsal, and the second dorsal smaller than the first dorsal; and from *P. zephyreus* J. & S., 1895, by the backward origin of the first dorsal, the lobeless caudal fin, and the spacing of the rostral teeth.

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Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows: —

H. AUGENER. The Annelids of the "Blake."
C. HARTLAUB. The Comatulae of the "Blake," with 15 Plates.
H. LUDWIG. The Genus Pentacrinus.
A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
R. T. HILL. On the Geology of the Windward Islands.
W. McM. WOODWORTH. On the Bololo or Palolo of Fiji and Samoa.
AGASSIZ and WHITMAN. Pelagic Fishes. Part II., with 14 Plates.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows: —

A. AGASSIZ. The Pelagic Fauna.
" The Panamic Deep-Sea Fauna.
H. B. BIGELOW. The Siphonophores.
K. BRANDT. The Sagittae.
" The Thalassicolae.
W. R. COE. The Nemerteans.
W. H. DALL. The Mollusks.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
J. P. McMURRICH. The Actinarians.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
M. P. A. TRAUSTEDT. The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.
W. McM. WOODWORTH. The Annelids.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to XLII., and also Vols. XLIV., XLV., and XLVII ; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVIII., XXIX., XXXI., and XXXII.

Vols. XLIII., XLVI., XLVIII., XLIX., and L. of the BULLETIN, and Vols. XXV., XXVI., XXVII., XXX., XXXIII., XXXIV., and XXXV. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Professors and Assistants of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation: —

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, in charge of Professor N. S. Shaler.

These publications are issued in numbers at irregular intervals; one volume of the Bulletin (8vo) and half a volume of the Memoirs (4to) usually appear annually. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Librarian of the Museum of Comparative Zoology, Cambridge, Mass.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. XLVI. No. 12.

VERTEBRATA FROM THE SAVANNA OF PANAMA.

Introduction. Mammalia.

By Outram Bangs.

Aves.

By John E. Thayer and Outram Bangs.

Reptilia: Amphibia.

By Thomas Barbour.

Pisces.

By Samuel Garman.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

January, 1906.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer "Albatross," from October, 1904, to March, 1905, Lieutenant Commander L. M. Garrett, U. S. N., Commanding, published or in preparation:—

A. AGASSIZ. General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
F. E. BEDDARD. The Earthworms.
H. B. BIGELOW. The Medusae.
R. P. BIGELOW. The Stomatopods.
S. F. CLARKE. The Hydroids.
W. R. COE. The Nemerteans.
L. J. COLE. The Pycnogonida.
W. H. DALL. The Mollusks.
C. R. EASTMAN. The Sharks' Teeth.
B. W. EVERMANN. The Fishes.
W. G. FARLOW. The Algae.
S. GARMAN. The Reptiles.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. The Schizopods.
S. HENSHAW. The Insects.
W. E. HOYLE. The Cephalopods.
C. A. KOFOID. III.[3] The Protozoa.
P. KRÜMBACH. The Sagittae.
R. VON LENDENFELD. The Sponges.
H. LUDWIG. The Holothurians.
H. LUDWIG. The Starfishes.
H. LUDWIG. The Ophiurans.
J. P. McMURRICH. The Actinaria.
G. W. MÜLLER. The Ostracods.
JOHN MURRAY. The Bottom Specimens.
MARY J. RATHBUN. The Crustacea.
HARRIET RICHARDSON. II.[2] The Isopods.
W. E. RITTER. The Tunicates.
ALICE ROBERTSON. The Bryozoa.
B. L. ROBINSON. The Plants.
G. O. SARS. The Copepods.
H. R. SIMROTH. The Pteropods and Heteropods.
TH. STUDER. The Alcyonaria.
T. W. VAUGHAN. The Corals.
R. WOLTERECK. The Amphipods.
W. McM. WOODWORTH. The Annelids.

[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z., Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.

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No. 12. — *Vertebrata from the Savanna of Panama.*[1]

CONTENTS.

I. Introduction. By Outram Bangs.

In the process of the John E. Thayer Expedition of 1904, Mr. W. W. Brown, Jr., spent nearly a month — the greater part of May, 1904 — near the city of Panama, making general collections of vertebrates.

The region is quite different in character from the hilly, heavily forested interior of the Isthmus, and is described in a letter by Mr. Brown as follows: "My headquarters are at Calidonia at the edge of the swamp of Panama, about a mile from the seashore and about seventy-five yards from the beginning of the mangroves. Toward the north and northeast, the low flat country or Savanna of Panama extends for some four or five miles, gradually rising, to the hills. This is a grassy plain, very dry and burnt in appearance, especially in the dry season, with little patches of wood — island like — scattered about here and there. Near the city of Panama there are several orange groves, where I collected Blue-creepers and some Tanagers that I did not see elsewhere."

We did not expect any novel results in the way of species from this collection, but the region is so different — dry and barren — from the country farther inland, at Loma del Leon, etc., where most of the bird collecting on the Isthmus has been done, that we felt it quite worth while to have a representative series from the Savanna of Panama.

Mr. Garman in his list includes the fishes from Gorgona Island and the Pearl Islands, as well as those from the vicinity of Panama, while Mr. Barbour notices the reptiles and amphibians from the vicinity of Panama and from the Pearl Islands.

[1] Papers from the John E. Thayer Expedition of 1904, No. 3.

II. Mammalia. By Outram Bangs.

During his stay of nearly a month, Mr. Brown set traps for the smaller mammals, at every sort of place on the Savanna of Panama and the edge of the mangrove swamps, but caught nothing, and he saw no signs of small mammals. When I stated this fact to Mr. E. W. Nelson, he said that his experience in Mexico had been much the same, and that such regions in middle America — low, hot, arid plains — are almost without mammalian life.

One vesper rat (*Oryzomys panamensis* Thomas; type locality, near city of Panama), however, has been described from this region.

Mr. Brown secured specimens of four species of mammals, — one squirrel and three bats.

SCIURIDAE.

1. Sciurus adolphei dorsalis (Gray).

Five adult specimens, both sexes, May 20 to 25.

These are all practically alike in color, except that in some the black is faded, usually in patches, by long wear, to a rusty brown. They are in the "Grizzled-backed phase" of Nelson, with head and back mixed black and yellowish; under parts pale buff; tail buff, below along middle, black above and on sides, each hair tipped with white. I cannot see that they differ from Costa Rican examples in the same phase of coloring. It is rather interesting that they do not, as north of Panama in Chiriqui and at Punta Burica, Costa Rica, the permanently black form — *Sciurus melania* (Gray) — occurs, which would thus appear to be merely a colony of melanistic individuals, and hardly a species (or subspecies) in the true sense of the term.

The flesh measurements are:

No.	Sex.	Total length.	Tail vertebrae	Hind foot.	Ear
10,810	♂ ad.	528	270	60	32
10,811	♂ ad.	522	280	60	31
10,812	♀ ad.	528	270	60	32
10,813	♀ ad.	523	270	60	30
10,814	♀ ad.	522	260	60	31

MOLOSSIDAE.

2. Promops nanus Miller.

One adult ♂, May 20.

PHYLLOSTOMATIDAE.

3. Hemiderma castaneum (H. Allen).

Seven specimens, young and adult, May 22 to 25.

4. Artibeus intermedius J. A. Allen.

One adult ♂, May 20.

III. Aves. By John E. Thayer and Outram Bangs.

The ornis of the Savanna of Panama and the mangrove swamps of the coasts of the bay, though interesting as compared with that of the interior of the Isthmus, is not rich in number of species. Mr. Brown's collection includes but eighty-six species, of which one only, the alder flycatcher, is a North American migrant. The country is little diversified, and so sparsely wooded that one would not look for a rich bird fauna.

The characteristic birds of the Savanna are the pigmy titlark, *Anthus parvus;* the red-breasted blackbird, *Leistes militaris;* the Lawrence's cacique, *Cacicus vitellinus;* the grassquit, *Tiaris olivacea dissita*, and the fork-tailed tyrant, *Muscivora tyrannus.* In the little islands of woodland scattered over the Savanna the smaller tyrants, ant thrushes, wrens, and other brush and forest-loving species were found in small numbers, while in the mangrove swamps Mr. Brown secured a few specimens of the rare mangrove warbler, *Chrysocantor erithachorides*, which, though very common in the mangroves of the Pearl Islands, was exceedingly rare in the swamps near the city of Panama.

The natives shoot large numbers of birds for food, and the species most persecuted are very shy and are decreasing in numbers; the grackle, *Megaquiscalus major macrourus*, the wood grouse, *Odontophorus marmoratus*, the ortalis, *Ortalis cinereiceps*, and the doves are the species most sought for.

In this paper we describe three new forms, — the momot, usually previously referred to the Colombian *Momotus subrufescens;* the Panama golden-crowned tyrant, which proves separable from *Tyrannulus reguloides;* and the grassquit, — a well-marked southern continental form of *Tiaris olivacea.*

During the month that Mr. Brown spent on the Savanna of Panama, he secured specimens of all the species observed.

ARDEIDAE.

1. Butorides striata (Linné).

One adult ♀, May 26, 1904. This skin, No. 14030, affords the following measurements: wing, 168.5; tail, 61; tarsus, 51; exposed culmen, 63. It does not appear to differ in any way from birds from Brazil and Guiana.

FALCONIDAE.

2. Buteo brachyurus Vieill.

One adult ♂ in the dusky phase of plumage, May 4.

3. Rupornis ruficauda (Scl. & Salv.)

One ♀, May 25.

CRACIDAE.

4. Ortalis cinereiceps (Gray).

One ♀, May 21.

ODONTOPHORIDAE.

5. Odontophorus marmoratus Gould.

Two males, one adult, May 23, one young, May 17. These are perfectly typical examples of *O. marmoratus*, and show no approach to *O. castigatus* of Chiriqui, which, notwithstanding Ogilvie-Grant's statement, is a very different well-marked form.

COLUMBIDAE.

6. Columbigallina minuta (Linné).

Seven adults of both sexes, May 10 to 26.

7. Claravis pretiosa (Ferrari-Perez).

Two adult males, May 14 and 21.

8. Leptotila verreauxi Bp.

Two males, one adult, May 18, one young, May 20.

CUCULIDAE.

9. Piaya cayana thermophila (Scl.).

Five adults, both sexes, May 4 to 21.

10. Diplopterus naevius (Linné).

Five adults, both sexes, May 19 to 25.

11. Crotophaga ani Linné.

One ♀, May 2.

PSITTACIDAE.

12. Brotogerys jugularis Müller.

Twenty-three, adults of both sexes, May 12 to 26.

MOMOTIDAE.

13. Momotus conexus, sp. nov.

Six adults, both sexes, May 6 to 26.

Type. — Coll. E. A. and O. Bangs, No. 14,054, adult ♀, Savanna of Panama, Panama, May 6, 1904.

Characters. — A very distinct form at once distinguished from *M. lessoni* Less. of Central America by its much smaller size and smaller bill, as well as different coloration, — the throat in *M. lessoni* being always green to base of bill, without a hazel chin-spot. From *M. subrufescens* Scl. of northern South America, the Panama bird differs in darker general coloration; the back is uniform dark green, becoming chestnut only on nape just below the blue of back of crown (in *M. subrufescens* the neck and mantle are pale tawny more or less suffused with light green); under parts much darker, — hazel or chestnut (tawny ochraceous-rufous in *M. subrufescens*), the throat and upper breast strongly suffused with dark green; a conspicuous hazel chin-spot.

Measurements. —

No.		Sex.	Wing.	Tail.	Tarsus.	Culmen.
14,054	type	♀ ad.	125.	228.	27.5	38.
14,055	topotype	♀ ad.	121.	217.	26.	40.
14,056	"	♂ ad.	126.	231.5	26.5	37.5
14,057	"	♂ ad.	121.	227.	27.5	38.
40,672 M.C.Z.	"	♀ ad.	118.	205. much worn	26.	37.
B.	"	♀ ad.	126.	219.	26.5	39.

Remarks. — The Panama bird has always been referred to *M. subrufescens* Scl. Type locality Santa Marta, Colombia, but is so different from that form in color that it must certainly be regarded as at least a subspecies, — but if a subspecies, then of what? All of the many recognized forms of blue-headed motmots, from eastern Mexico south to Amazonia and Bolivia, are so much alike, it would not be at all surprising to find that in reality they are all but representative geographical races — subspecies — of one wide-ranging variable species.

ALCEDINIDAE.

14. Ceryle americana septentrionalis Sharpe.

Three, both sexes, May 4 to 26.

CAPRIMULGIDAE.

15. Nyctidromus albicollis (Gmel.).

One male, May 26.

16. Stenopsis cayennensis (Gmel.).

One adult ♂, May 4.

17. Anthrostomus rufus (Bodd.).

One adult ♀, May 6.

TROCHILIDAE.

18. Amizilis tzalatl (L. Lave).

Two males, May 4 and 9.

TROGONIDAE.

19. Trogon caligatus concinnus (Lawr.).

One adult ♂, May 15.

PICIDAE.

20. Melanerpes wagleri wagleri Salv. & Godm.

Two males, May 11 and 20.

FORMICARIIDAE.

21. Thamnophilus transandeanus Scl.[1]

Four adults, both sexes, May 4 to 22.

22. Thamnophilus atrinucha Salv. & Godm.

One adult ♀, May 13.

23. Thamnophilus nigricristatus Lawr.

Six adults, both sexes, May 7 to 10.

[1] The nomenclature of the ant thrushes here followed is that of Sharpe's Hand List, Vol. 3, 1901.

24. Rhamphocaenus rufiventris (Bp.).

Three adult males, May 8 and 9.

25. Cercomacra tyrannina (Scl.).

One ♂, May 21.

26. Cercomacra nigricans Scl.

Seven adults, both sexes, May 6 to 21.

27. Drymophila swainsoni Berlepsch.

Six adults, both sexes, May 9 to 11.

28. Hypocnemis naevioides (Lafr.).

Three adults, both sexes, May 14 to 26.

DENDROCOLAPTIDAE.

29. Xiphorhynchus[1] nanus nanus (Lawr.).

Three specimens, both sexes, May 11 to 25.

PIPRIDAE.

30. Chiroxiphia lanceolata (Wagl.).

Ten adults, both sexes, May 3 to 26.

31. Manacus vitellinus (Gould).

Fifteen specimens, both sexes, May 3 to 21.

TYRANNIDAE.

32. Todirostrum cinereum finitimum Bangs.

Two adult males, May 2 and 17.

33. Todirostrum schistaceiceps Scl.

One adult ♀, May 8.

34. Colopteryx pilaris (Cab.).

Two adults, ♂ and ♀, May 8.

35. Myiopagis placens accola Bangs.

One adult ♀, May 13.

[1] For change from *Dendrornis* to *Xiphorhynchus*, cf. Oberholser, Smith. Misc. Coll., Vol. 48, pt. 1, No. 1579, pp. 62–63, May 13, 1905.

36. Capsiempis flaveola (Licht.).

Five adults, both sexes, May 7 to 18.

37. Ornithion pusillum (Cab. & Heine).

Two adults, ♂ and ♀, May 5 and 13.

38. Tyrannulus reguloides panamensis, subsp. nov.

Three adults, ♂ ♂, ♀, May 6 to 22.

Type. — Coll. E. A. and O. Bangs, No. 14,092, adult ♂, Savanna of Panama, May 6, 1904.

Characters. — Similar to true *T. reguloides* Ridg. of the Lower Amazons, but larger; paler in color below, especially on the breast and sides; back and rump lighter, clearer green, the back markedly so.

Measurements. —

No.	Sex.	Locality.	Wing.	Tail.	Tarsus.	Exposed Culmen.
14,092	♂ ad.	City of Panama	49	40	12.2	6.8
14,091	♂ ad.	do.	48	38	12.	6.8
14,093	♀ ad.	do.	48	39	12.2	7.
8,035	♀ ad.	Chiriqui, Divala	47	39	12.	7.

Remarks. — This little tyrant is quite different from *Tyrannulus elatus* (Lath.), and in a former paper was referred by Bangs to true *T. reguloides* Ridg., on the strength of one female collected by Brown at Divala, Chiriqui. The three additional examples taken at Panama on the present trip, caused us to doubt its identity with the form of the Lower Amazons and we sent all four examples to Mr. Harry C. Oberholser who kindly compared them with the type. He found the Panama bird represents a fairly well constituted northern subspecies, differing from true *T. reguloides* in its larger sizes, paler yellowish green breast, paler yellow sides, and lighter clearer green back and rump.

39. Elainea pagana subpagana Scl. & Salv.

Eight adults, both sexes, May 2 to 11.

40. Elainea albivertex Pelz.

Seven adults, both sexes, May 2 to 21. These are very similar to the series from Santa Marta on which *E. sororia* Bangs was based, but are slightly smaller and thus approach *E. sordidata* of the Pearl Islands. The bill, however, is not so large as in the island form.

41. Sublegatus arenarum Salvin.

One adult ♂, May 17.

42. Myiozetetes cayennensis (Linn.).

Two adults, ♂ and ♀, May 2 and 7.

43. Myiozetetes similis superciliosus (Bp.).

Six specimens, young and adult, May 4 to 21.

44. Myiodynastes audax nobilis (Scl.).

Three adults, both sexes, May 2 to 26.

45. Onychorhynchus mexicanus mexicanus (Scl.).

Four specimens, both sexes, May 11 to 26.

46. Myiobius atricauda (Lawr.).

Two specimens, ♂ and ♀, May 6 and 8.

47. Myiobius naevius naevius (Bodd.).

Two adult males, May 3 and 17.

48. Empidonax traillii alnorum Brewst.

Two females, May 2 and May 6. All other North American migrants had left for the north by May; and Mr. Brown saw resident species only, except this Empidonax. The alder flycatcher does not arrive on its breeding grounds in eastern North America till the first week in June, and leaves for the south again so early that on a former trip Mr. Brown took one at Pedregal, Panama, Aug. 21. It thus appears to spend a shorter time in the north than any other migratory small bird. The two specimens have been identified by Mr. William Brewster.

49. Myiarchus ferox panamensis (Lawr.).

Two adult males, May 6 and 19.

50. Muscivora tyrannus (Linné).

Five adults, both sexes, May 4 to 26.

TURDIDAE.

51. Merula grayii casius (Bp.).

Six adults, both sexes, May 4 to 11.

TROGLODYTIDAE.

52. Phengopedius fasciato-ventris albigularis (Scl.).

Four adults, both sexes, May 4 to 10.

53. Phengopedius hyperythrus (Salv. & Godm.).

Five adults, both sexes, May 4 to 14.

54. Troglodytes musculus inquietus (Baird).

Five adults, both sexes, May 3 to 19.

55. Thryophilus rufalbus castanonotus Ridg.

Twelve adults, both sexes, May 5 to 21.

56. Thryophilus galbraithii galbraithii (Lawr.).

Nine adults, both sexes, May 5 to 22.

57. Thryophilus modestus elutus Bangs.

Three males, two adult, one young, May 5 to 11.

VIREONIDAE.

58. Vireosylva flavoviridis flavoviridis Cassin.

Seven adults, both sexes, May 2 to 8.

59. Pachysylva aurantiifrons aurantiifrons (Lawr.).

Four adults, both sexes, May 4 to 11.

60. Pachysylva viridiflava (Lawr.).

Nine adults, both sexes, May 2 to 26. All these have pale bills, while the two skins collected by Mr. Brown in Chiriqui have the bill black; otherwise the Panama and Chiriqui birds seem to be identical. (See Ridgway, Birds N. and Mid. Amer., Vol. 3, p. 221, foot-note b.)

HIRUNDINIDAE.

61. Progne chalybea chalybea (Gmel.).

One young male, May 20.

MOTACILLIDAE.

62. Anthus parvus Lawr.

Eighteen specimens, adults of both sexes and young, May 9 to 24

MNIOTILTIDAE.

63. Chrysocantor erithachorides (Baird).

Five adult males, May 17 to 21. All taken in the mangrove swamps, where they were not at all common, and very hard to obtain.

64. Basileuterus ruffifrons mesochrysus (Scl.).

Five adults, both sexes, May 3 to 11.

65. Rhodinocichla rosea eximia Ridg.

Nine adults, both sexes, May 4 to 25.

COEREBIDAE.

66. Cyanerpes cyaneus (Linné).

Nine adult males, May 12 to 26.

67. Dacnis cayana ultramarina (Lawr.).

Five adults of both sexes, May 8 to 25.

ICTERIDAE.

68. Zarhynchus wagleri wagleri (Gray).

Two adult females, May 15.

69. Cacicus vitellinus Lawr.

Twenty-four specimens, adults of both sexes, May 13 to 26, and two young in nestling plumage, — ♂, May 26, ♀, May 23.

The young (nestlings) differ from the adults in having the yellow portions much paler and without the orange tint, the black duller and browner, and in having very small, weak bills.

70. Amblycercus holosericeus (Licht.).

Twelve adults, both sexes, May 2 to 20.

71. Megaquiscalus major macrourus (Swainson).

One adult female, May 25. The grackle is one of the birds relentlessly hunted for food by the natives, and is found, consequently, in very small numbers, and is exceedingly shy.

72. Leistes militaris (Linné).

Twenty-two specimens, adults of both sexes, May 20 to 26; and one young female in nestling plumage, May 26. This differs from the adult ♀ only in having the feathers of the back and wings, except the primaries, edged all round with yellowish brown.

TANAGRIDAE.

73. Tanagra cana Swainson.

Two adult males, May 4 and 22.

74. Ramphocelus dimidiatus isthmicus Ridg.

Twenty-seven adults, both sexes, May 2 to 23. This is a strongly characterized subspecies; its long tail and pale colors, and the brownish patch on the belly in the male at once separating it from true *R. dimidiatus* of Colombia. It is a remarkable fact in distribution, however, that the Chiriqui bird is true *dimidiatus*, and the Panama form occupies, so far as known, only a small area along the Panama Railroad.

75. Tachyphonus rufus (Bodd.).

One adult ♀, May 26.

76. Eucometis cristata (Du Bus.).

Two adults, ♂ and ♀, May 21 and 26.

77. Phoenicothraupis fuscicauda erythrolaema (Scl.).

Ten adults of both sexes, May 4 to 26.

In his "Birds of North and Middle America," Part 2, p. 153, Ridgway states that though some Panama birds were paler than northern examples, the subspecies is not worthy of recognition. The present series of ten examples, however, seems to prove that there is a very pallid race, perhaps confined to the arid region immediately about the city of Panama, as a series from Loma del Leon formerly referred to this subspecies by Bangs belongs rather with true *P. fuscicauda*.

The type in Sclater's collection (now in the British Museum) was supposed to have come from Santa Marta, Colombia. We, however, entertain some doubt as to this supposed origin, because none of the collectors who have visited the Santa Marta region of late years have secured the bird there, and ant tanagers are birds that most collectors secure. Be this as it may, however, the type belongs to the pale form now under consideration.

Recently, when Mr. Gerritt S. Miller, Jr., was in the British Museum, we sent him specimens of both forms, which he carefully compared with the Sclater type, and wrote us that it agreed with the pale birds from the Savanna of Panama.

P. fuscicauda erythrolaema differs from true *P. fuscicauda* in its paler colors throughout. The male has the throat patch much paler (pale scarlet), the rest of the plumage paler and duller, the occiput and sides of head decidedly grayer; the female paler, more olive, less brown.

FRINGILLIDAE.

78. Arremonops conirostris conirostris (Bp.).

Ten adults, both sexes, May 2 to May 23.

79. Volatinia jacarini splendens (Vieill.).

One adult ♂, May.

80. Tiaris olivacea dissita, subsp. nov.

Nine adults, both sexes, May 2 to 14.

Type. — Coll. E. A. and O. Bangs, No. 14,212, adult ♂, Savanna of Panama, May 12, 1904.

Characters. — Similar in color to *T. olivacea intermedia* Ridgw. from Cozumel Island, but much smaller. Differing from *T. olivacea pusilla* (Swains.) from Mexico, in that the adult male never has the crown and auricular region black Adult ♀ rather greener, less grayish than the adult ♀ of *T. olivacea pusilla.*

Color. — Adult ♂, supraloral spot, eye-brow, chin, upper throat, and spot on lower eye-lid bright yellow; lower throat, breast, lores, malar region, and anterior portion of forehead, and a narrow line along sides of crown, black; top of head and rest of plumage dull grayish olive, paler, more whitish on middle of belly. Adult ♀, plain grayish olive, the black and yellow markings of the male usually slightly indicated, paler, more whitish, on the middle of the belly.

Measurements. —

No.	Locality.	Sex	Wing.	Tail.	Tarsus.	Culmen.
14,212	Savanna of Panama	♂ ad.	49.5	37.5	16.2	8.8
14,213	do.	♂ ad.	49.	38.	16.4	9.2
14,214	do.	♂ ad.	49.5	34.	16.4	9.2
14,215	do.	♂ ad.	48.5	39.5	15.8	9.2
40,786	M. C. Z. do.	♂ ad.	50.	40.	16.8	9.4
40,785	M. C. Z. do.	♂ ad.	49.5	39.	16.8	9.4
40,787	M. C. Z. do.	♂ ad.	49.	39.	17.	9.4
40,788	M. C. Z. do.	♀ ad.	48.	38.	16.	9.2
14,216	do.	♀ ad.	48.	35.	15.8	9.2
7,590	Loma del Leon, Panama.	♂ ad.	48.	40.	16.4	9.4
9,313	Boquete, Chiriqui.	♂ ad.	50.	40.	16.8	9.
9,314	do.	♂ ad.	49.	38.	16.2	9.2
9,315	do.	♂ ad.	49.	40.	16.4	9.4

Remarks. — There appears to be a wide gap in Central America between the ranges of the present form and *T. olivacea pusilla*, where no grassquit occurs. The new form extends from the Bogota region north to Costa Rica; *T. olivacea pusilla* from eastern Mexico south to Guatemala, leaving most of Guatemala and Nicaragua, Honduras and Salvador, between the ranges of the two, apparently unoccupied by a member of the genus.

T. olivacea dissita can at once be separated from true *T. olivacea olivacea* of the Greater Antilles by the black of the under parts extending over the breast, otherwise it is much like it; from *T. olivacea intermedia* of Cozumel Island,

which it greatly resembles in color, by its smaller size; and from *T. olivacea pusilla* of Mexico by the adult male having the crown and auriculars olive, not black.

81. Sporophila minuta minuta (Linné).

Eight specimens, adults of both sexes, and one young male, May 2 to 19.

82. Sporophila gutturalis (Licht.).

One adult ♂, May 2.

83. Sporophila aurita (Bp.).

Nine adults, both sexes, May 2 to 24.

84. Oryzoborus funereus Scl.

Nine specimens, adults of both sexes, and two young males, May 3 to 22.

85. Saltator magnoides intermedius (Lawr.).

Eight adults, both sexes, May 4 to 23.

86. Saltator albicollis isthmicus (Scl.).

Nine adults, both sexes, May 6 to 22.

IV. Reptilia and Amphibia. By Thomas Barbour.

A considerable number of reptiles and amphibians were taken by Mr. Brown on San Miguel and Saboga Islands. He collected also in the vicinity of the city of Panama, and the specimens obtained in all of these localities are included in this paper. The fauna of the islands is not fundamentally different from that of the mainland, whence all the species on the islands appear to have been derived. A few differentiated forms are, however, recognizable.

GECKONIDAE.

1. Gonatodes caudiscutatus (Günther).

Distribution. — Panama, Colombia, and Ecuador.

Of this common species there are sixty-five examples from San Miguel Island and eleven from Saboga Island.

2. Gonatodes fuscus (Hallowell).

Distribution. — Colombia and Central America.

This species is represented by twenty-three examples from San Miguel Island and fifteen from Saboga Island.

3. Sphaerodactylus lineolatus Lichtenstein.

Distribution. — Central America.

Thirteen specimens from San Miguel Island.

4. Thecadactylus rapicaudus (Houttuyn).

Distribution. — Central and South America and the Antilles.

Eighteen specimens from Saboga Island and six from San Miguel Island.

IGUANIDAE.

5. Anolis sallaei Günther.

Distribution. — Central America.

San Miguel four specimens, and thirty-nine from Saboga Island.

6. Basiliscus americanus Laurenti.

Distribution. — Central America.

Eleven from Panama, thirteen from San Miguel Island, and four of unknown locality. Adults and young, males and females.

7. Iguana tuberculata Laurenti.

Distribution. — Lesser Antilles, Central and South America.

A single specimen from Saboga Island.

8. Ctenosaura completa Bocourt.

Distribution. — Mexico and Central America.

With some hesitation I place under this species six specimens from San Miguel Island and one from Panama.

TEIIDAE.

9. Ameiva surinamensis (Laurenti).

Distribution. — Central and South America.

This lizard was apparently very common, for six were taken on San Miguel Island and twenty near Panama. As four specimens lost their locality labels in transportation the species may be represented on Saboga Island also.

SCINCIDAE.

10. Mabuia agilis (Raddi).

Distribution. — Mexico, Central and South America.

To this species Dr. Stejneger referred four specimens from Panama, and for his kindness in examining these and other specimens I thank him heartily.

TYPHLOPIDAE.

11. Typhlops emunctus Garman.

Distribution. — Panama.

A single specimen from San Miguel Island, 135 mm. in length, appears to belong to this species. It is in rather poor preservation, and the details of the head scales are very vague.

BOIDAE.

12. Epicrates sabogae, sp. nov.

Types. — No. 6986, Mus. Comp. Zoöl.

Two specimens, one entire, and one skin from Saboga Island.

This island species approaches *E. cupreus* Fischer in color. It is rather dark reddish brown. Its squamation, however, distinguishes it at once from the mainland form. The scales are extremely small. Boulenger (Cat. Snakes, Brit. Mus., vol. 2, p. 95) says that the scales in *E. cenchris* are in 45–51 rows; he also includes *E. cupreus* in this species. The Saboga specimens have scales in 65 and 67 rows, an excess of 14 and 16 over the maximum number for *E. cenchris.* The number of ventrals and subcaudals, 242 and 247, and 49 and 70, do not show any great variation from the continental form, though 70 is 4 in excess of the largest ventral scale count cited by Boulenger. Both specimens are the same size and measure four feet in length. The perfect specimen appears to be an adult male.

COLUBRIDAE.

13. Spilotes salvinii Günther.

Distribution. — Mexico and Central America.

Two large specimens were taken on San Miguel Island.

14. Herpetodryas fuscus (Linné).

Distribution. — Tropical South America.

With this very variable species I identify two snakes from San Miguel Island and eight from Saboga Island.

15. Drymobius margaritiferus (Schlegel).

Distribution. — Mexico to Colombia and Venezuela.

Three examples from Panama.

16. Leptophis occidentalis (Günther).

Distribution. — Central and Northwestern South America.

Six specimens from San Miguel Island.

17. Himantodes cenchoa (Linné).

Distribution. — Mexico, Central and tropical South America.

A single typical example from San Miguel Island.

18. Leptodira personata Cope.

Distribution. — Lower Mexico and Central America.

A single specimen from San Miguel Island has its scales in twenty-three rows.

19. Oxyrhopus cloelia (Daudin).

Distribution. — Continental tropical America and the Lesser Antilles.

Two specimens from Panama.

20. Oxybelis acuminatus (Wied).

Distribution. — Continent of tropical America.

This species is represented by two specimens from Panama, nine from San Miguel Island, and ten from Saboga Island. The locality tags were lost from several other specimens.

21. Homalocranium fuscum (Bocourt).

Distribution. — Central America.

A single specimen from Panama.

22. Hydrus platurus (Linné).

Distribution. — Indian and tropical Pacific Oceans.

It is interesting to find in this series, from a limited region, varieties C, D, and E which Boulenger describes on page 268 of the catalogue of snakes in the British Museum, vol. 3.

Mr. Brown took fourteen specimens at San Miguel Island and twelve at Saboga Island.

23. Elaps fitzingeri Jan.

E. fulvius D. Boulenger Cat. Snakes, Brit. Mus., 1896, vol. 3, p. 425.

Distribution. — Mexico and Central America.

Three specimens from San Miguel Island.

24. Elaps fulvius (Linné).

Distribution. — Southeastern North America, Mexico, and Central America.

A single specimen from Panama.

COECILIIDAE.

25. Coecilia ochrocephala Cope.

Distribution. — Panama.

A single specimen from the type locality.

26. Coecilia gracilis Shaw.

Distribution. — Northern South America.

A single specimen apparently of this form is before me, from Panama. This locality is rather distant from the hitherto known range of the species. There are 199 circular rings, all of which are interrupted dorsally except the hindermost. The great majority of the rings are characteristically interrupted ventrally also. A few, however, are complete below.

27. Coecilia sabogae, sp. nov.

Types. — Two specimens, No. 2425 Mus. Comp. Zoöl., from Saboga Island.

Head narrowing anteriorly, snout decurved, projecting acutely beyond mouth; eyes visible or almost invisible; tentacle on the under surface of snout, directly below the nostril. 175–180 circular folds, equidistant, complete above and below. Slate gray, plicae darker, head much lighter. Total length 272 and 381 mm., diameter 7 and 8 mm. (The specimens have evidently shrunken.)

ENGYSTOMATIDAE.

28. Phryniscus laevis Günther.

Distribution. — Western South America.

A single male from Panama.

CYSTIGNATHIDAE.

29. Leptodactylus insularum, sp. nov.

Types. — Twelve specimens, No. 2424, Mus. Comp. Zoöl., from Saboga Island.

Dr. Stejneger, who has very kindly examined specimens of this species, writes me as follows: "They seem to belong to the *L. caliginosus* group, some of which seem to have dorso-lateral folds. I cannot make up my mind to identify them with any of the described species. The angularity of the teeth seems to be extreme, and recalls *L. fragilis* Bocourt and *L. raniformis* Werner, the latter from Colombia, but these are supposed to be without dermal edges to the toes." Dr. Stejneger also adds that these specimens are much larger than certain so-called *L. melanonotus* which are in the United States National Museum, and which are probably adult because the males have well-developed manual spines.

Tongue oval, slightly nicked behind. Vomerine teeth in two slightly curved series behind the choanae. Nostril nearer the tip of the snout than the eye. Tympanum half the width of the eye. Toes very conspicuously fringed. Subarticular tubercles well developed; two small metatarsal tubercles. Skin smooth, with few warts above. A ventral discoidal fold and well-marked dorso-lateral folds. Deep slaty above with indistinct darker marking.

A dark heart-shaped spot on the occiput. In females hinder side of thighs with marbling of brown; males with thighs the color of the dorsum. Male with an internal vocal sac, and two spine-bearing tubercles in the inner side of the first digit. These manual spines are deep black. The males, which seem to have been taken in the breeding season, have the fore limbs very much swollen.

Mr. Brown also took several specimens on San Miguel Island.

30. Hylodes brocchi (Brocchi).

Distribution. — Guatemala.

One specimen from San Miguel Island.

BUFONIDAE.

31. Bufo marinus (Linné).

Distribution. — South and Central America, West Indies.

Two specimens from San Miguel Island.

32. Bufo spinulosus Wiegmann.

Distribution. — Northwestern South America.

Two examples from Panama.

HYLIDAE.

33. Hyla leucophyllata Beiris.

Distribution. — Tropical South America.

Five examples from Panama.

V. Pisces. By Samuel Garman.

Among the species secured by this expedition there are some of particular importance on account of being previously unrepresented in the collection of the Museum; all of them appear to have been described heretofore. The embryonic material is of especial interest and value.

The list includes the following: —

Carcharinus cerdale Gilb.	Panama.
Carcharinus aethalorus J. & G.	"
Carcharinus azureus Gilb.	"
Sphyrna zygaena Linné.	"
Ginglymostoma cirratum Gmel.	"
Urolophus aspidurus J. & G.	"
Dasybatus longa Garm.	"
Myliobatis asperrimus Gilb.	"

Aetobatis narinari Euph.	Panama.
Batrachus pacifici Günt.	"
Eleotris pictus Kner.	Gorgona.
Eleotris dormitatrix Bl. & S.	"
Eleotris maculata Bloch.	Panama.
Gobius soporator C. & V.	San Miguel.
Achirus fonsecensis Günt.	Panama.
Achirus scutum Günt.	"
Trachinotus fasciatus Gill.	Gorgona.
Lutianus aratus Günt.	"
Lutianus argentiventris Pet.	San Miguel.
Pristipoma humile K. & S.	Gorgona.
Eucinostomus californiensis Gill.	San Miguel.
Agonostoma nasutum Günt.	Gorgona.
Mugil curema C. & V.	San Miguel.
Poecilia elongata Günt.	" "
Poecilia boucardii Steind.	Panama.
Galeichthys eigenmanni G. & S.	"
Tetragonopterus panamensis Günt.	San Miguel.

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows: —

H. AUGENER. The Annelids of the "Blake."
C. HARTLAUB. The Comatulae of the "Blake," with 15 Plates.
H. LUDWIG. The Genus Pentacrinus.
A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
R. T. HILL. On the Geology of the Windward Islands.
W. McM. WOODWORTH. On the Bololo or Palolo of Fiji and Samoa.
AGASSIZ and WHITMAN. Pelagic Fishes. Part II., with 14 Plates.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows: —

A. AGASSIZ. The Pelagic Fauna.
" The Panamic Deep-Sea Fauna.
H. B BIGELOW. The Siphonophores.
K. BRANDT. The Sagittae.
" The Thalassicolae.
W. R. COE. The Nemerteans.
W. H. DALL. The Mollusks.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
J. P. McMURRICH. The Actinarians.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
M. P. A. TRAUSTEDT. The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.
W. McM. WOODWORTH. The Annelids.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to XLII., and also Vols. XLIV., XLV., and XLVII; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVIII., XXIX., XXXI., and XXXII.

Vols. XLIII., XLVI., XLVIII., XLIX., and L. of the BULLETIN, and Vols. XXV., XXVI., XXVII., XXX., XXXIII., XXXIV., and XXXV. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Professors and Assistants of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation: —

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, in charge of Professor N. S. Shaler.

These publications are issued in numbers at irregular intervals; one volume of the Bulletin (8vo) and half a volume of the Memoirs (4to) usually appear annually. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Librarian of the Museum of Comparative Zoölogy, Cambridge, Mass.

26.693

Bulletin of the Museum of Comparative Zoology

AT HARVARD COLLEGE.

VOL. XLVI. NO. 13.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUT. COMMANDER L. M. GARRETT, U. S. N., COMMANDING.

IV.

OCTACNEMUS.

BY WILLIAM E. RITTER.

[Published by Permission of GEORGE M. BOWERS, U. S. Fish Commissioner.]

WITH THREE PLATES.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

JANUARY, 1906.

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A. AGASSIZ. V.[5] General Report on the Expedition.

A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.

A. AGASSIZ and H. L. CLARK. The Echini.

F. E. BEDDARD. The Earthworms.

H. B. BIGELOW. The Medusae.

R. P. BIGELOW. The Stomatopods.

S. F. CLARKE. The Hydroids.

W. R. COE. The Nemerteans.

L. J. COLE. The Pycnogonida.

W. H. DALL. The Mollusks.

C. R. EASTMAN. The Sharks' Teeth.

B. W. EVERMANN. The Fishes.

W. G. FARLOW. The Algae.

S GARMAN. The Reptiles.

H. J. HANSEN. The Cirripeds.

H. J. HANSEN. The Schizopods.

S. HENSHAW. The Insects.

W. E. HOYLE. The Cephalopods.

C. A. KOFOID. III.[3] The Protozoa.

P. KRÜMBACH. The Sagittae.

R. VON LENDENFELD. The Sponges.

H. LUDWIG. The Holothurians.

H. LUDWIG The Starfishes.

H. LUDWIG. The Ophiurans.

J. P. McMURRICH. The Actinaria.

G. W. MÜLLER. The Ostracods.

JOHN MURRAY. The Bottom Specimens.

MARY J. RATHBUN. The Crustacea.

HARRIET RICHARDSON. II.[2] The Isopods.

W. E. RITTER. The Tunicates. IV.[4]

ALICE ROBERTSON. The Bryozoa.

B. L. ROBINSON. The Plants.

G. O. SARS. The Copepods.

H. R. SIMROTH. The Pteropods and Heteropods.

TH. STUDER. The Alcyonaria.

T. W. VAUGHAN. The Corals.

R. WOLTERECK. The Amphipods.

W. McM. WOODWORTH. The Annelids.

[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.

[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.

[3] Bull. M. C. Z., Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.

[4] Bull. M. C. Z., Vol. XLVI., No. 13, January, 1906, 22 pp., 3 pls.

[5] Mem. M. C. Z., Vol. XXXIII., January, 1906, 88 pp., 96 pls.

Bulletin of the Museum of Comparative Zoölogy

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IV.

OCTACNEMUS.

By William E. Ritter.

[Published by Permission of George M. Bowers, U. S. Fish Commissioner.]

With Three Plates.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

January, 1906.

No. 13. — *Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of* ALEXANDER AGASSIZ, *by the U. S. Fish Commission Steamer "Albatross," from October, 1904, to March, 1905,* LIEUT. COMMANDER L. M. GARRET, U. S. N., *Commanding.*

IV.

OCTACNEMUS. By WILLIAM E. RITTER.

FIVE specimens of this remarkable animal were taken by the "Albatross" during her cruise under the direction of Mr. Agassiz in the winter of 1904–1905; two at station No. 4649, and three at station No. 4656. The first mentioned was in latitude 5° 17′ south, and longitude 85° 19.5′ west, at a depth of 2,235 fathoms; the second in latitude 6° 54.6′ south, and longitude 83° 34.3′ west, in 2,222 fathoms. These positions are between three hundred and four hundred miles off the coast of Ecuador.

The "Challenger" specimens of *Octacnemus* were also taken at two stations; one, No. 218, in latitude 2° 33′ south, and longitude 144° 4′ east; and the other, No. 299, in latitude 33° 31′ south, and longitude 74° 43′ west. The first of these was in 1,070 fathoms, the second in 2,160 fathoms.

It will be seen from this that the "Albatross" specimens are from practically the same zoölogical region and the same depth as those of the "Challenger" station No. 299, this being approximately the same distance from the coast of Peru that the "Albatross" stations are from the Ecuador coast. It may be noted further that both localities are in the course of the Humboldt current. The first "Challenger" specimen, the one on which Moseley founded the genus, was, on the other hand, taken from just north of New Guinea, consequently the whole width of the Pacific Ocean from the locality of the others.

Although expressing the view that the South American specimen was probably the same species as the one studied by Moseley, Herdman, who

alone examined the former, pointed out, at the same time, that it possessed a much larger prominence on the "dorsal edge" (posterior part) of the body than did Moseley's individual. In this particular the "Albatross" specimens agree with the one studied by Herdman, and differ strikingly from the well-known figure of the type drawn by Moseley.

Of the five specimens in this collection, kindly entrusted to me by Mr. Agassiz, three are in exceptionally good condition; the fourth is badly mutilated, parts of it being wanting; while the fifth is so fragmentary as to be of little value. In fact it is possible that the parts which I have considered as constituting the fourth and fifth all belong to one; so that in reality there may be only four individuals.

As to general characteristics of the oral disc and rays, my observations agree so nearly with what we already know of the animal from Moseley and Herdman that it would be superfluous to go over the ground in detail. Comparison of my figures with the figures by these authors will reveal at a glance the slight differences I have noticed. Probably the most important of these is in the relative size of the rays. There is, I think, rather more difference in both length and width between the two anterior, and the two posterior rays in all the "Albatross" specimens, than either Moseley's or Herdman's figures indicate. In the largest individual the anterior rays measure 4 cm. in length, while the posterior are 3 cm. Again, I do not find the tips of the rays to agree quite with the published figures. They taper more gradually and terminate in sharper points than Moseley and Herdman have shown; and Moseley speaks of the rays as terminating in "abruptly narrowed tentacle-like tips." This, however, is probably merely a matter of preservation. The "Albatross" material is preserved in rather strong formalin, and this is a much better preservative than alcohol for all tunicates, at least so far as the conserving of general form and color is concerned. This makes it worth while to remark that no pigment has been observed in any part of these specimens excepting a very faint yellow mark along the peripharyngeal band, the deep orange-red of the sense organ, the light yellow of the gonads, and the brown of the intestine. As the material came under my observation within eight months after its preservation, it is quite certain that the animal is almost entirely colorless.

In one individual the whole "nucleus" is everted through the branchial orifice and lies on the oral disc. This condition has enabled me to make out several points that would probably have escaped notice

otherwise. One of these is the presence of a decided ventral, or anterior, lip to the branchial orifice. This is shown in Plate 1, Figure 1. This considerably resembles the lip in the corresponding position in various species of *Salpa*, though as we shall see later this resemblance can have no taxomomic significance. In the normal specimen in preservation it gives the orifice a more semilunar shape, Figure 1, than Herdman's Figure 6 indicates.

As already stated, the posterior enlargement, on whose dorsal and posterior surface the atrial orifice is situated, is more like that in Herdman's than in Moseley's specimen. As a matter of fact, in all the "Albatross" individuals it is even larger than in Herdman's figure. This is, I consider, really to be accounted as part of the body of the animal instead of a prominence on the body, as Herdman has expressed it.

But the most important extension of our information about the superficial characters of the species I am able to make is in connection with the adhesive disc. The interest attaching to this comes from the question of whether or not the animal really lives fixed to the bottom or is a swimmer, at least for a portion of its life. Moseley states that the "process," as he calls the part of the animal of which we are now speaking, is "terminated outwardly in a tangled mass of rootlets, massed amongst which was found much sand and shell-particles from the bottom." "The ascidian," he says, "was evidently attached by this process or pedicle." The minute structure of the rootlets Moseley appears not to have attended to particularly. With reference to the South American specimen Herdman says: "The dorsal projection which contains the viscera is roughened on its lower surface, and if the body were attached to some foreign object it must have been by this part." Herdman has always, as I judge from mention of *Octacnemus* in various of his publications, regarded it as only probable that the animal is attached. Metcalf, 1893, 1900, observed the hair-like processes on *O. patagoniensis*, recognized their similarity with those on various simple ascidians, and consequently did not hesitate to conclude that this is an attached species.

It is thus seen that all who have studied *Octacnemus* have regarded it as a bottom dweller. My observations certainly confirm this view; but at the same time the strength of the circular muscle bands of the oral disc suggests that at some period in its life the animal may possibly be a swimmer.[1] It is possible, however, that the co-ordinated action of

[1] Since writing the above Mr. Agassiz has called my attention to the fact that he has recorded (Mem. Mus. Comp. Zoöl., Vol. 26, p. 91) the taking of *Octacnemus*

the radial and circular muscles might find sufficient occupation in producing the movements necessary for the intake and discharge of the water essential to respiration and nutrition.

The rootlets of *O. herdmania* are not merely processes of the test, as Metcalf, 1900, speaks of those of *O. patagoniensis* as being. Each is a tube whose wall is of test, and within which is a delicate axial muscle band consisting of two or three fibres. Here and there along this band nuclei are to be seen. In general structure these rootlets resemble more closely those of *Rhizomolgula* Ritter, 1901,. than of any other ascidian with which I am acquainted. They are, however, much more delicate here than in that molgulid. They do not branch here as there, each arising direct from the body of the animal. They are not more than three or four mm. long. It is usual for ascidian root-hairs of this sort to cling with great tenacity to the mud and sand in which they are embedded, so that they are freed from foreign particles with difficulty. It is, consequently, surprising to find them quite clean in *Octacnemus*. This fact suggests that the animal is not very firmly anchored to the bottom. But while the individual rootlets were entirely devoid of foreign particles clinging to them, entangled among them were many slender, sometimes branched, brown tubes. These seem to belong to the foraminiferous genus, *Rhizammina* of Brady, and to be close of kin to *R. algaeformis*. In addition to these, numerously present over the entire adhesive disc of all the specimens, several fragments of a hexactinellid sponge were entangled among the rootlets of one individual. Finally, a few Globigerinae were associated with the rhizopod tubes.

Moseley mentions that the "border of the base [i. e. of the ventral surface of the oral disc] is thickened into a slightly prominent, rounded ridge, running round the periphery of the entire basal area." This author's schematic section of the animal, shown in a text figure, indicates this prominence at *b*. This ridge is decidedly more than "slightly prominent" in the "Albatross" specimens. In life it must amount to a

with the tow-net in 150 fathoms. This was during his Expedition to the Tropical Pacific in 1899–1900, the station at which the capture was made being in lat. 4° 35′ N., and long. 136° 54′ W. Mr. Agassiz also tells me by letter that *Octacnemus* was taken at two or three other localities between 300 fathoms and the surface. With this information, and with what seems to me the certainty that the animal rests on the bottom at times, the question of the life habits of the species becomes of increased interest. NOTE BY A. AGASSIZ. — It is very probable that the fragments of the bottom sometimes found in the rootlets of *Octacnemus* have become entangled in them while in the trawl on its way to the surface after the specimens were obtained in bathymetrical belts less than 300 fathoms.

flange of three or four mm. in height. Instead of being rounded, as in Moseley's animal, it is narrow even at its base, and thins off to an almost sharp edge. The test along the very edge is somewhat hardened, and so changed in structure that it refuses to take stain as do the remaining parts. Even in the preserved animal, this flange with its meandering course is a conspicuous object on the ventral surface of the disc (Plate 1, Fig. 2). Its position is not at the periphery of the disc, in the region of the rays, as Moseley says, but is four or five mm. in toward the centre from the line of the base of the rays. Posteriorly the flange passes on to the atrial part of the body. It reaches back to the region of the adhesive disc, where it gradually disappears, and hence differs decidedly from its course in *O. bythius*, where it is continuous *behind* the adhesive patch. It would appear that the whole ventral surface rests on the substratum, to which, however, the creature is attached by the adhesive disc alone. The thickenings of the test, or pads on the bases of the rays, mentioned by Herdman, are present here, but extend farther toward the ends of the rays than they did in Herdman's specimen.

Concerning the microscopic structure of the test, and the circular and radial muscles of the mantle, I have nothing to add to what Moseley and Herdman have recorded.

The most important differences, both as to observation and interpretation, between my results and those reached by these naturalists, relate to the branchial sac and the parts immediately associated therewith. Both Moseley and Herdman sought in vain for branchial stigmata; and, failing in this, were misled in their conclusions as to the whereabouts of the branchial chamber. Both naturally assumed it to be the great cavity within the oral disc. As it becomes clear from the present study that the branchial stigmata and the branchial chamber are located in quite a different region, the question arises as to the significance of the chamber of the oral disc, supposed by them to be branchial. It will be convenient to make the consideration of this the starting point of our account of the internal structure of the animal. We begin by examining the wall of the oral disc external to the chamber. Were the cavity a true branchial cavity, comparable with that of other ascidians, we should have, passing from without inward, the following layers: the test, the ectoderm, the mantle, and immediately lining the cavity an extension of the respiratory epithelium. I have examined this wall with especial care, both on stained and unstained flat preparations, and on microtome sections, and *fail to find anything but the layer of test.*

Likewise the "horizontal membrane," separating the supposed bran-

chial from the peribranchial, or ventral chamber should be composed of an epithelium constituting each surface layer, with something of the mantle (blood-spaces at least) between. But here, likewise, examination of microtome sections fails to reveal such structure as would be expected. The tissues are so highly specialized in the adult state of the animal that it is difficult if not impossible to say definitely just what we have before us. Herdman has described a squamous epithelium as extending over the "general surface of the membrane," without, however, specifying which surface is thus covered. Such an epithelium is undoubtedly present, but on *one surface of the membrane only, and that the ventral or deeper surface.* The relation of the different elements entering into the structure of the membrane can be particularly well made out by examining a flat preparation from the portion in the base of the arms where the muscle fibres are well developed. Seen from the dorsal surface the squamous epithelium is found at a deeper level considerably than the fibres; and from the level corresponding to the fibres down to that of the epithelium, numerous cellular elements not constituting a uniform layer, but composed of several kinds of cells, some large and spherical, others smaller and more or less spindle-shaped, are present. Microtome sections show the epithelial layer to be exceedingly thin, and give the impression that the layer is interrupted in places. This latter is probably not in reality true. The flat preparations examined give no intimation of such a state. Sections of the membrane show in addition to its cellular constituents a considerable quantity of more or less homogeneous, or somewhat fibrous material strongly resembling test. This occupies in general the surface opposite the epithelium, i. e. the dorsal surface.

My interpretation of the membrane is that in life it was closely adherent throughout by its dorsal surface to the test wall of the oral disc, and became separated from the latter only on the death of the animal. This would mean that the large *dorsal chamber of the oral disc, regarded by Moseley and Herdman as branchial, is an artifact.* On this view the homogeneous test-like material mentioned above as entering into the structure of the membrane would be accounted for by supposing that the rupture plane was within the test for a short distance. The ragged character of the dorsal surface of the membrane, as seen on the sections, confirms this interpretation. If this is right, the ectoderm of the region involved should be present in the membrane dorsal to the muscle fibres where these exist. I am unable to recognize anything that can with certainty be regarded as such a layer, either in this membrane or in the

test wall. I therefore conclude that the ectoderm has undergone such extreme modification, the secretion of test having been completed, that it is no longer recognizable by the methods of examination employed. This disappearance of the ectodermal layer in adult tunicates would appear to be no unusual thing. I recall especially my inability to demonstrate the presence of the layer in the root-hairs, or tubes of *Rhizomolgula* (Ritter, :01), where it must certainly have existed at an early period in the life of the individual. It would seem that in many, perhaps most, cases there is no addition to, nor renewal of, the test in tunicates after it has once been fully formed, at least as far as the ectoderm, the original source of the cellulose matrix, is concerned. Whether the test cells, derivatives of the mesoderm, take up this office and replace the ectoderm in it is an interesting question on which we have, so far as I am aware, no positive information.

In order to make my interpretation square with certain facts observed not only by Moseley and Herdman, but as well by myself, and with certain other statements and conjectures by my predecessors, a brief consideration of the points involved is necessary.

In the first place, all our observations agree in finding the branchial orifice to open directly into the dorsal chamber, as the diagrammatic sectional figure of Herdman shows (see Fig. 1). Of course, if my

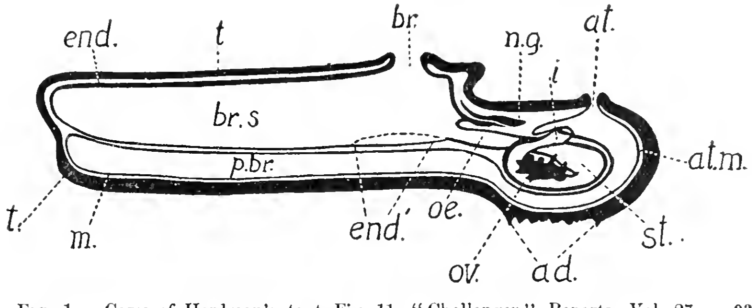

Fig. 1. — Copy of Herdman's text Fig. 11, "Challenger" Reports, Vol. 27, p. 93. For the letterings of Fig. 1 and Fig. 2, see p. 251.

interpretation is correct, this cannot be so in life, as reference to text Figure 2 makes obvious. It follows then that the cavity would have to be regarded as due to rupture. This rupture is probably caused by the contraction, at death, of the strong muscle bands at *m. b.*" Figures I and 3, the position of which is also indicated in text Figure 2. As the layer in which these fibres are situated (the homology of which will be seen

later), is always found to continue into the horizontal membrane, the line of rupture would have to be supposed to be at the point x in the section represented by Figure 2. It will be seen that the layers to be ruptured in this position would be the ectoderm and the test, or the line at which the test terminates within the branchial orifice. But the extreme delicacy of the ectoderm has already been pointed out; hence one may readily believe not only that rupture here would occur with ease, but also that the severed edges of the ruptured layers might be observed with difficulty. As a matter of fact, one of the chief obstacles that I have found to this interpretation is the absence of local evidence of rupture.

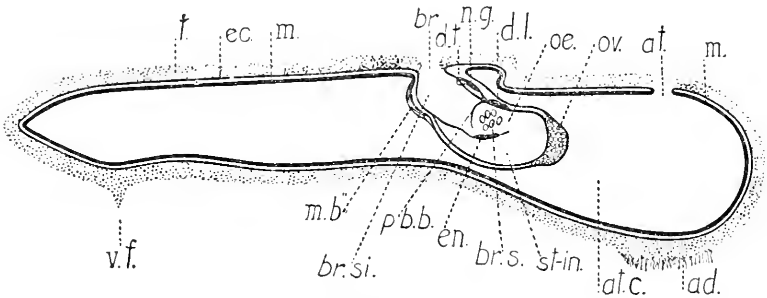

FIG. 2. — A schematic section of the animal corresponding to that shown in Fig. 1, to show my interpretation of the relation of the several parts, as contrasted with Herdman's.

Attention may be called to the circumstance that the wall within the branchial orifice opposite the supposed rupture is intact, as the figure indicates; and that consequently this rupture is restricted to the region corresponding to the muscle bands, *m. b.''*

My interpretation of the horizontal membrane finds strong confirmation, it seems to me, in these statements by Moseley: "The membrane was observed to be attached to the inner surface of the test wall at the intervals between the conical processes; but the specimen was too much injured to allow of the investigation of the extent and manner of its attachment within the conical processes. It appeared to be attached laterally on either side to the inner walls of these processes, and is probably reflected so as to line their cavities." And again: "No reflection of the membrane over the inner surfaces of the upper and lower walls of the test was observed."

Moseley speaks repeatedly of the more thickened central portion of the horizontal membrane, the portion thus characterized being in general, one is led to infer, the distinctly octagonal area shown in his figures of

the entire animal, to the angles of which the radial muscles are attached. He remarks that "opposite the indentations in the margin of the thickened central portion of the membrane, the thin lamina [which is described elsewhere as a continuation of the horizontal membrane] is loose, and hangs in bags or depressions." The condition here described is, I gather, what gives one the impression from his figures that the oral disc is occupied by a great sac that extends to the very base of the arms, even bellying into the arms somewhat, and is quite distinct from the octagonal central area to which the eight radial muscles are attached. In other words Moseley found the sac in his animal considerably more complicated than it is in that now under examination; and the points brought out by him are of such a character as to justify the belief that he was dealing with a different creature. This is another of the particulars which persuades me that two species of *Octacnemus* should be recognized.

Herdman refers to the mantle in the specimen studied by him as adhering closely to the inner surface of the test. As, however, this statement is made in close connection with what he says about the musculature, I judge he refers only to the mantle within the arms. Herdman describes a number of pits in the horizontal membrane, the significance of which he was in doubt about, but which he conjectures may represent branchial stigmata. I have seen a few of what may be the same structures, though I fail to make out that they are as definite or as numerous as they were in the specimen studied by Herdman. I have no suggestion as to their meaning, but they certainly cannot be homologous with branchial stigmata.

The cavity below the horizontal membrane, which is immediately continuous with the great chamber occupying almost the whole of the animal, I regard, with Moseley and Herdman, as probably atrial, or atrial and peribranchial. This cavity is without partitions, so far as I have observed. It, of course, opens to the outside world through the atrial aperture, which is nearly circular and without distinguishable lobes or markings of any kind. The view that this chamber is atrial is borne out by the fact that the "nucleus" (in reality, as we shall presently see, the whole viscera proper) is so loosely suspended within it. Two or three facts however, to be pointed out presently, throw some doubt on the correctness of this interpretation.

We may now turn to the examination of the visceral mass. The exact position within the test envelope which this occupies in life is by no means clear. In all my specimens, as with those taken by the "Chal-

lenger," it was very small as compared with the size of the animal as a whole. It was in the form of a nearly spherical mass, and was situated underneath the posterior part of the oral disc. I consider it quite likely that in life the mass is considerably more elongated, and extends through a greater portion of the distance between the two orifices. But this is entirely conjecture, so the question need not detain us now.

The most noteworthy thing pertaining to the intimate structure of the visceral mass is the fact that the true *branchial sac is situated within it, or constitutes a part of it.* An understanding of the orientation and structure of the mass becomes clear by examining the figures in the order mentioned, 8, Plate 3, 3, 4, and 5 Plate 2. The dissection from which Figure 8 was drawn is seen at once by comparing this figure with Figure 1. From these it will be seen that the branchial orifice opens directly into a capacious tube, in reality the homologue of the inner part of the branchial siphon of ordinary ascidians. This is shown as cut in Figure 8. On the ventral side it carries the longitudinal muscle bands *m. b''.* of Figure 1, and shown from within in Figures 3 and 4. The ventral wall of this tube, it will be seen, passes directly over into the so-called horizontal membrane (*h. m.*, Fig. 3). On the dorsal surface of the mass (Fig. 8) one sees the rather conspicuous ganglion (*n. g.*), the sub-neural gland (*s. gl.*), the dorsal half of the peripharyngeal band (*p. b. b.*), and on close examination, the dorsal lamina (*d. l.*). All these organs are situated on what seems, from a dissection like that shown in Figure 8, to be the relatively very large stomach. At the posterior margin of the mass are seen the ovary (*ov.*) and testis (*tes.*).

Figure 3, Plate 2, represents the visceral mass of the same specimen as that shown in Figure 8, but removed from the test, enlarged considerably, and with the piece carrying the ganglion, gland, etc., cut out. Examination of the piece on its inner surface, with a low power, reveals the fact that two distinct membranes enter into its composition, and that the inner of these is perforated by a considerable number of elliptical but more or less irregular orifices (Fig. 9, Plate 3). Perforations of the same sort were also found later on the portion of the wall not cut away (Fig. 3, *br. s.*). Each orifice is bordered by a rather decided epithelial thickening, the inner margin of which has few, but the outer very many, nuclei (Fig. 6, Plate 2). I have found no intimation of cilia fringing the orifices. The absence of cilia on the apertures, the somewhat peculiar structure of their bordering epithelium, and their irregular distribution, are traits in which they differ considerably from the more typical branchial stigmata of ascidians. Nevertheless there

can be no doubt about their identity. Their general character, but most of all their relation to other clearly identifiable parts, leave no room for hesitation. They are, as will be noted especially from Figure 9, Plate 3 situated on each side of the dorsal lamina, *d. l.*, and behind the ganglion and peripharyngeal band. Furthermore, as we shall see presently, though far removed from the endostyle, their general relation to this organ is as it should be. Absence of cilia and the peculiar structure of the bordering epithelium are probably associated with the fact that the stigmata are no longer functional as respiratory organs.

But while there is no doubt that these orifices are branchial stigmata, and consequently that the membrane in which they occur is the strict homologue of the branchial membrane of other ascidians, the fact that only the inner one of the two layers above pointed out seems to constitute the visceral wall (Figs. 3, 5, 8, and 9 *m.* and the layer immediately beneath it) is perforated by the stigmata, does raise a difficult question as to the peribranchial cavity, i. e. the cavity into which the stigmata of the typical ascidian open externally.

Something of the character of this external, unperforated layer is suggested by the facts that a series of six or eight distinct, though rather delicate, muscle bands (Fig. 9, *m. b'.*) are situated in it, and extend across the median dorsal line, and are disposed at nearly regular intervals from before backward; and that the same layer extends over the gonads (Fig. 3, *m.*). The suggestion from these facts is that the layer belongs in reality to the mantle; and its resting immediately upon the branchial membrane suggests farther that the *peribranchial cavity has become obliterated*, or, more exactly, reduced to the very narrow interval between the two membranes. On this interpretation the large cavity beneath the "horizontal membrane" in the oral disc, which was above regarded, with some doubt, as the peribranchial-atrial chamber, would not be such; at least would not be peribranchial (the condition here described was the occasion for the reservation as to identification, not indicated in my treatment of that subject).

I am unable to reach entire clearness on these points. It is possible that further study on additional material, particularly on young or developing specimens, will find that the atrial chamber is here distinctly set off from the peribranchial, and that the great interior space already described is atrial and not at all peribranchial; or it may be that this whole space is artifact, as I have interpreted the portion above the horizontal membrane to be. This, however, seems hardly probable, though such a view would furnish an explanation of the apparent

absence of an epithelial layer on the inner surface of the test of the ventral side of the oral disc. I have searched in vain for such an epithelium. I regret the necessity of leaving these points, important to a full understanding of the morphology of this most interesting creature, still obscure.

We may now examine a little more attentively the other structures belonging to the branchial sac. What I have called the dorsal lamina is really not a lamina at all, nor has it the languets that usually take the place of a lamina when such a structure is wanting. Here we have two irregular, approximately parallel, bands of somewhat thickened epithelium, with a narrow interval between them (Fig. 9, *d. l.*). These are, as compared with the organ in typical ascidians, relatively short, they being but a little longer than the combined length of the ganglion and neuro-hypophyseal gland (Fig. 8, *d. l.*).

The peribranchial band (Fig. 9, *p. b. b.*) is also of an unusual character. It consists of a thickened ridge of epithelium, continuous on each side with the corresponding band of the dorsal lamina; the peribranchial ridge being, however, less clearly defined than the dorsal bands. These bands are so irregular in both outline and definition as to defy exact representation in a drawing.

An area of uniform, thinner epithelium occupies the angle between the diverging peribranchial bands, and in this are situated the *ganglion*, and *gland* with its *duct*. The ganglion is anterior and dorsal to the gland, and from the three large nerves given off from it i. e. a pair extending forward, and a single median one extending backward, is somewhat triangular in form. The nerves of the pair are much, larger than the single posterior nerve. This is correlated with the fact that it is the anterior nerves which supply the oral disc. These nerves can be traced forward along the "horizontal membrane," each giving off branches which go to the arms and musculature of the disc. They are large and elaborately branched, thus showing that the regions supplied by them are well enervated.

A detailed study of the nerves and their terminals, particularly the sensory terminals, would in all likelihood yield interesting results. The gland (Fig. 9, *s. gl.*, Plate 3) is nearly spherical, and as above indicated is situated ventral to, and behind the ganglion. On its ventral surface is a ridge extending somewhat diagonally fore-and-aft. This is in all probability a portion of the duct, though I have not made out with certainty a connection between it and the large thin-walled *dorsal tubercle* (Fig. 9, *d. t.*). This tubercle, or hypophysis funnel, opens forward

and decidedly to the right, by a large elliptical, plain mouth. The wall of the funnel is very delicate. I have seen no cilia in any part of it. Within the funnel were observed six or seven rather distinct deep-orange pigment spots.

Owing to the differences between my results and those reached by Moseley and Herdman relative to the branchial sac, the question of the *endostyle* is especially important. Both these observers having failed to find the branchial stigmata, based their conclusions to a considerable extent on what they supposed to be the endostyle. Herdman, however, recognized that the structure believed by him to be this organ was not the same as that held by Moseley to be such. It is now certain that *neither Moseley nor Herdman saw the true endostyle.*

Having found, in the manner above detailed, that the cavity opened into by removing the dorsal patch of visceral wall, as shown in Figure 3, must be the true branchial cavity, I proceeded to carefully remove the food material and refuse by which this cavity was completely filled.[1] Having cleaned this out thoroughly, examination of the floor of the chamber discovered the groove indicated at *e. n.*, Figure 4, Plate 2. Both from its position and structure, (though in this latter respect there was considerable disguising) there could be no doubt that the true endostyle had been come upon at length. By dissecting out the piece containing the organ, and examining it with more care, it was found that the typical endostylar structure could be made out, and, further, that anteriorly the organ connected in the usual way with the peripharyngeal band (Fig. 7, *en.* and *p. b. b.*, Plate 2). The two lips of the organ were unusually far apart, and their irregularity in outline and minuter composition gave to the organ as a whole something of the peculiarities already indicated as characterizing both the dorsal lamina and the peripharyngeal band. And here, as in all the parts of the branchial sac where cilia would be expected, no trace of them could be found. *The entire apparatus, it is probable, has lost its original respiratory function, and has become devoted to the nutritive office;* and the peculiarities of structure of various parts, notably of the stigmata, dorsal lamina, endostyle, and peripharyngeal band are, it would seem, due in large measure to this change of function.

Whether the branchial wall has actually become digestive or not, I am unable to say with certainty. However, from the great amount of food material contained in the cavity, much of which was in various

[1] I was able to identify with approximate certainty in the stomach contents, portions of a copepod, a schizopod, a pycnogonid, a tanais, and a young fish.

stages of disintegration; from the character of the epithelial lining of the chamber, sections of which prove it to be composed, in part at least, of more or less columnar cells; and, finally, from the wide communication of this cavity with the true stomach, this communication being in no clear way marked off from the two connected cavities, I judge that to a considerable extent *the branchial membrane has become digestive.*

The branchial chamber of the ascidian being, as is now universally recognized, the highly modified anterior end of the digestive tract, if the class be supposed to have had an ancestor in which the region was truly digestive; and if the conjecture that in *Octacnemus* the branchial membrane has secondarily acquired the digestive function, we should have here the very unusual instance of an organ resuming its original function after having become highly modified for a wholly different function. The data are rather too dubious to make profitable much speculation as to whether this resumption of the original function could be attributed in any wise to a true reversion; that is, to the influence of a long-dormant character. But assuming such a resumption to have taken place, the fact might be more naturally accounted for by the influences, direct or indirect, of life at the great depth in which the animal lives. It seems that for numerous deep-sea ascidians, respiration does not demand the service of any such elaborate mechanism as that possessed by the typical shoal-water members of the class. In a considerable series of species, widely separated taxonomically, the branchial membrane is much reduced in one way and another. Instances of this are furnished by *Ascopera*, *Corynascidia*, *Hypobythius*, and a new and remarkable form found off the coast of California at 2,000 fathoms, which I have studied but have not yet described. Wherefore this diminution of importance of the branchial organ for respiratory purposes, is not obvious; given the fact however, there would appear no special difficulty in conceiving that the cavity might gradually be turned over to the food-taking and digestive functions.

Continuing our examination of the viscera, we find a wide but very short passage from the posterior end of the branchial cavity (Fig. 4, *oe.*, Plate 2) into another still more capacious chamber lying immediately beneath the floor of the cavity already described. The passage-way is clearly the oesophagus, and the large chamber the true stomach; or more exactly a stomach-intestine; for it is not sharply set off from a true intestine. This chamber (*st.-in.*, Fig. 5, Pl. 2) extends forward, narrowing down rapidly to a very small, short rectum. The exact position of the anus I have unfortunately not been able to find; though it

is obviously somewhat to the right and ventral side of the branchial sac. It is certainly not in the position occupied by it in the animal described by Moseley. Herdman gives us no information on this point for his specimen, and I therefore conclude that he did not see it, and assume this to be another particular in which the species studied by him and myself differs from that studied by Moseley.

The position of the anus in this species is of special interest since the location of it would throw some light on the question of the atrium.

The position and character of the *gonads* are indicated in Figures 3 and 4, Plate 2. The ovary is a rather voluminous mass applied closely to the posterior border of the digestive tract. In two of the specimens the ova are numerous and apparently near maturity. They are quite spherical, and measure about .32 mm. in diameter. The characteristic ascidian "test" cells are present and make a layer of considerable thickness, though it is not uniform over the entire egg. The testis, much less voluminous than the ovary, is situated at the left end of the ovary, closely applied to it, and also to the digestive tract. It is of a lighter color than the ovary, and is divided into numerous small rounded lobes.

I am unable to find an oviduct, and believe that none exists. The ova probably escape by dehiscence. What appears to be a sperm duct runs forward for a short course closely applied to the ventral intestinal wall (consequently not visible on any of the figures). The branched strand shown in Figures 3 and 4, Plate 2, crossing the concavity of the ovary toward the right, appears to be a mantle fold, probably serving as a ligament to hold the ovary in place. The possibility of its belonging to the blood vascular system naturally suggests itself; but it certainly has nothing to do with this system. I have, however, seen nothing of either heart or blood vessels. No "liver" or excretory organ appears to be present, nor has the chyliferous organ been found.

From the fact that the *Octacnemus patagoniensis* of Metcalf seems to propagate by budding, I have naturally looked with care for evidence of such a mode of propagation here; but none has been found. I do not believe it occurs, and this it seems to me is one weighty reason for holding that the species studied by Metcalf should be regarded as generically distinct from the animal named *Octacnemus* by Moseley.

We may turn now to the question of the wider affinities of the Octacnemidae. The present investigation makes it obvious, as Metcalf had already furnished ample reasons for believing, that they are not related to *Salpa*, but to the simple or colonial ascidians. Herdman's suggestion that their relationship is with *Salpa* has been so generally accepted

that it will probably be a long time before the matter can be set straight in general zoölogy; but it should be recalled that the suggestion was made with such reservation as would be expected from so careful and experienced a zoölogist as Herdman, on a point concerning which there was at the time such imperfect knowledge. "On the whole," are his words, "I regard this form as being allied to *Salpa*." It would seem that this conclusion was based chiefly on the supposed correspondence of the visceral mass to the "nucleus" in *Salpa;* and the supposition that the endostyle of *Octacnemus* is located in the floor of the cavity, taken to be branchial, within the oral disc. Had Herdman found the true branchial sac with the stigmata and endostyle, it is quite certain he would not have suggested the kinship of the animal to *Salpa*. With the information at his command, his conclusion was justified.

As to exactly what genus among the simple ascidians *Octacnemus* has most in common it is not yet possible to say. Certain it is, though, that there is nothing to support the conjecture of Moseley that it is related to *Cystingia*. Metcalf's suggestion that it is related to the Clavelinidae has perhaps as much in its favor as any that can now be made. I would point out, however, that the branchial sac, in particular, suggests the genus *Hypobythius* of Moseley. This genus alone shares with *Clavelina* and some of its nearest allies, the character of having a branchial sac without folds or internal longitudinal bars; besides this its stigmata are irregular in size and distribution. In this latter particular it seems that *Octacnemus* resembles *Hypobythius* quite decidedly. The stigmata of *Octacnemus* are perhaps too few in number to warrant the assertion that they are irregular in both respects. They are certainly so as to size; and there are in *Octacnemus* neither folds nor internal vessels or papillae. The simplicity of the digestive tract of *Hypobythius* and its close approximation to the side of the branchial sac are likewise points of resemblance to *Octacnemus*. It must be noted, however, that the stomach-intestine of *Hypobythius* rests on the dorsal side of the branchial sac, while in *Octacnemus* it is ventral and dextral. I do not think it worth while to make much of the comparison between these two genera, our knowledge of both being still too imperfect, but one other point may be referred to. Moseley's original description of *Hypobythius* indicates that its oral surface is decidedly flat, and that the atrial orifice is far to one edge, if indeed not beyond, this disc. With *O. patagoniensis* in mind it is not difficult to imagine a disc like that of *Hypobythius* to be a starting point for the production through modification, of a tentaculated disc, first like that of *O. patagoniensis*, and finally like that of *O. bythius* and *O. herdmania*.

Only one step further will I pursue this comparison. *Hypobythius* is a distinctly pedunculated ascidian. This fact might be held as an obstacle in the way of kinship between it and *Octacnemus*. On the other hand, the relatively small and distinctly circumscribed adhesive patch of *Octacnemus* might be looked upon as a remnant of the peduncle. One might be warranted in speculating that by the principle of correlated, or compensatory, growth, the great oral disc of *Octacnemus*, with its eight arms, has been gained, in part at least, by the loss of an ancestral peduncle. Possibly suggestive in this connection is the fact that the peduncle of *H. moseleyi* Herdman, is short as compared with that of *H. calycodes* Moseley.

In concluding these tentative remarks on the affinities of *Octacnemus*, it may be noted that my suggestion of relationship to *Hypobythius* is not widely at variance from Metcalf's of its possible affinity to the Clavelinidae; for *Hypobythius* and *Clavelina* are certainly not remote in their kinship.

In the present imperfect state of our knowledge it would hardly be profitable to enter into a detailed consideration of the relationship between Metcalf's *O. patagoniensis* and the species now under treatment. I therefore rest satisfied with pointing out the chief reasons for holding that Metcalf's species should be assigned to a different genus, which, however, I refrain from characterizing or naming. These are: the absence of the well defined and distinctly set off oral disc, and especially the absence from the disc of the system of circular and radial muscle bands that are so characteristic of *Octacnemus*: its asexual method of propagation; its single pair of branchial stigmata; and perhaps the position of its atrial orifice. Having regard for generic distinctions as they prevail generally in the Tunicata, there can, I think, be no question that the characters thus indicated are sufficiently distinctive to justify this proposal.

I conclude by presenting a revision of the genus *Octacnemus*, and a diagnosis of *O. herdmania*.

Octacnemus Moseley, 1876.

Body attached by a restricted, clearly defined disc, situated posteriorly and ventrally; this disc carrying a great number of minute root filaments. Anterior end differentiated into a distinct oral disc, the margin of which carries eight prominent arms.

Test gelatinous, thin, transparent.

Mantle for the most part very delicate; though on the dorsal side and within

the arms of the oral disc having an elaborate system of circular and radial muscle bands.

Visceral Mass very small, relative to the size of the animal as a whole; but loosely held within the enormous atrial chamber.

Branchial Sac situated within the visceral mass; functionless as a respiratory organ, but devoted to the nutritive function; stigmata not numerous, irregular in size, form, and distribution; walls of sac without folds or internal vessels or papillae; dorsal lamina very short, in the form of two low ridges; endostyle likewise short and broad.

Digestive Tract very short and broad, closely applied to the ventral side of the branchial sac; liver and renal organ wanting.

Gonads forming a compact mass closely applied to the posterior border of the digestive tract. Ovary much larger, more or less cylindrical, situated immediately behind the stomach; apparently no oviduct. Testis placed at the left end of the ovary, finely lobular, lighter in color than the ovary; a short sperm duct running forward on the ventral side of the intestine.

Octacnemus herdmani.

Octacnemus bythius Herdman, 1888, p. 88, and 1891, p. 648; Metcalf, 1900, p. 572; and other authors, none of whom have examined the animals themselves.

Posterior, or Atrial end of the animal large and distinctly set off from the *anterior, disc-bearing* end.

Ventral Flange of the oral disc prominent, angular in section, and not continuous around the disc posteriorly, but each side running on to the atrial portion of the animal, there to gradually disappear on each side of the attachment patch, *which is entirely behind the plane of the oral disc on the atrial part of the body.*

Mantle of the Oral Disc not thickened in central portion, or otherwise structurally set off for the other portions.

Rectal portion of the intestine not projecting beyond the visceral mass; anus far forward.

Distribution, eastern portion of South Pacific.

In order to bring out clearly the contrast between this species and *O. bythius* Moseley, I subjoin a characterization of the latter species also.

Posterior, or Atrial end of the animal much reduced, so that the attachment patch is situated on the ventral side of the oral disc.

Ventral Flange rounded, and continuous entirely around the ventral side of the oral disc; hence not running on to the sides of the attachment patch.

Mantle of the Oral Disc thickened in the central portion, this thickened part octagonal in outline, the rays being the points at which the radial muscles are inserted; a small pit in the membrane in each interval between the rays, and just beyond the thickened central area.

Rectal portion of the intestine projecting considerably beyond the visceral mass, the anus directed backward and upward.

These specific differences will be readily seen by comparing Figures 1 and 2, Plate 1, with Figures. 2 and 1 respectively, Plate 10, of Herdman's Report (1888); these latter being copies of Moseley's figures.

Abbreviations.

a.	anus.
ad.	adhesive patch.
at.	atrial orifice.
at. c.	atrial chamber.
br.	branchial orifice.
br. s.	branchial stigmata.
c. b. s.	cavity of branchial sac.
d. l.	dorsal lamina.
d. t.	dorsal tubercle.
ec.	ectoderm.
en.	endostyle.
en. f.	endostylar fold.
h. m.	"horizontal membrane."
int. b.	intestinal band.
m.	membrane together with the epithelium lining the atrial chamber.
m. b., *m. b′.*, *m. b″.*,	muscle bands.
m. r.	radial muscles.
n.	anterior nerves.
n. g.	nerve ganglion.
n. z.	nucleated zone.
n. n. z.	non-nucleated zone.
o. br.	opening into branchial sac by dissection.
oe.	oesophagus.
ov.	ovary.
p. b. b.	peripharyngeal band.
r. n.	rapheal nerve.
s. gl.	subneural gland.
st. in.	stomach-intestine.
t.	test.
tes.	testis.
v. f.	ventral flange.

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PLATE 1.

Fig. 1. Dorsal view, natural size, of *Octacnemus herdmani.* The radial muscle fibres in each muscle do not in general diverge quite as much toward their insertion on the mantle as this figure indicates.

Fig. 2. Ventral view of the same specimen. The oral disc as marked by the ventral flange is somewhat too broad.

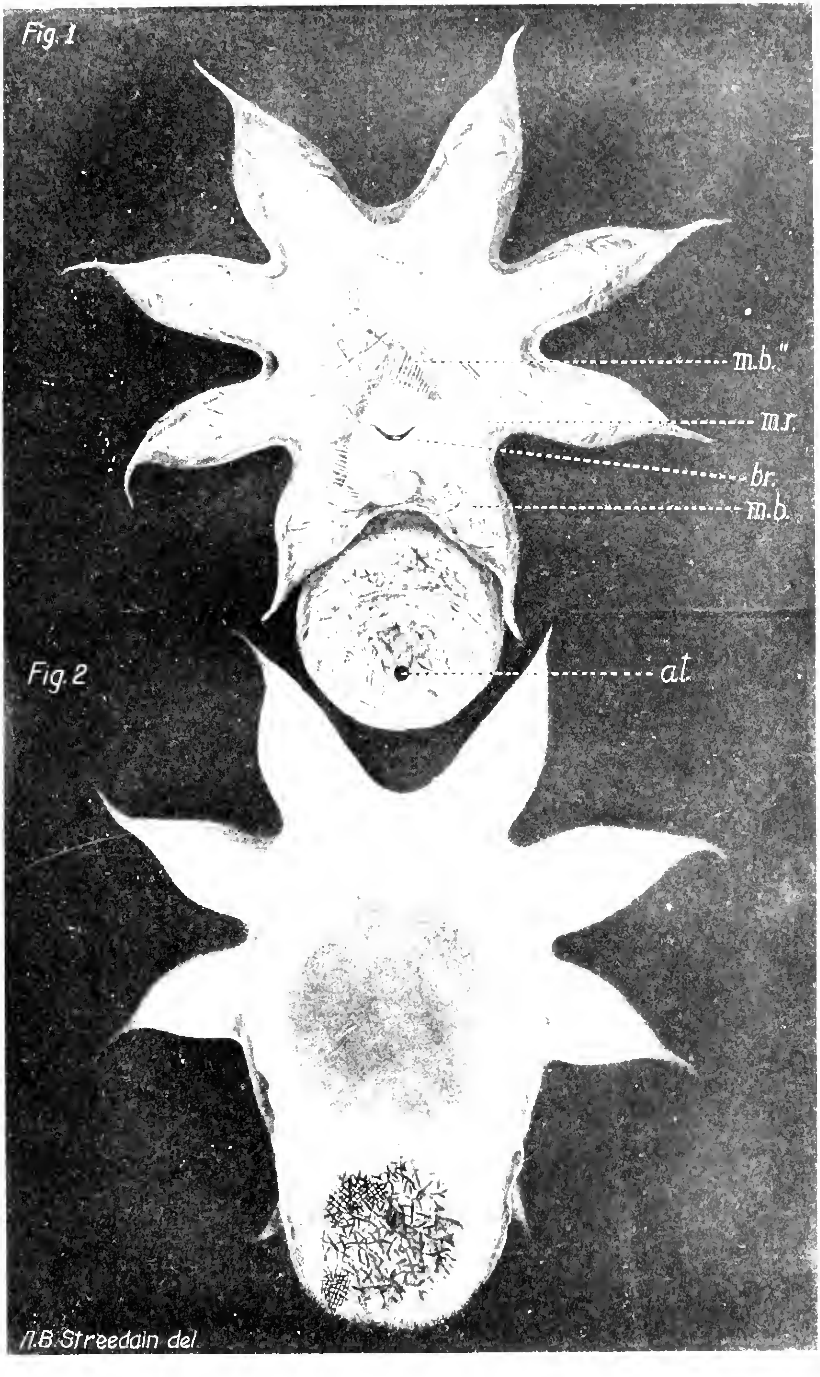


Fig. 1
m.b."
m.r.
br.
m.b.
at.
Fig. 2
N.B. Streedain del.

PLATE 2.

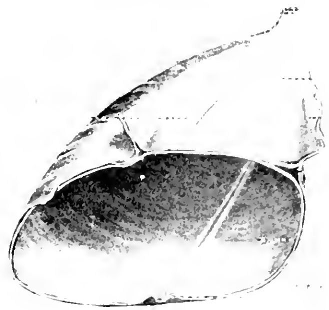
FIG. 3. This should be compared with Figure 8, Plate 3. Dorsal view of the visceral mass, removed from the test, and a section, part of which is shown on its inner surface in Figure 9, Plate 3, cut from the dorsal side of the branchial sac.

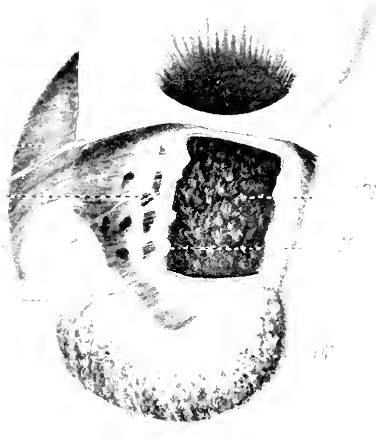
FIG. 4. Same as Figure 3, excepting that the cut has been somewhat extended, and the food material entirely removed from the branchial sac.

FIG 5. The stomach-intestine, from the dissection shown in Figure 4, made by a transverse cut corresponding to the line *y* of Figure 4.

FIG. 6. A single branchial orifice much enlarged.

FIG. 7. The endostyle with a portion of the peribranchial band.





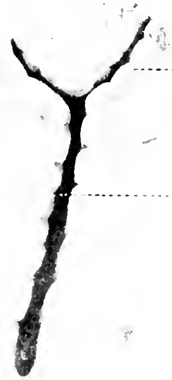


PLATE 3.

FIG. 8. Comparison of this with Figure 1, Plate **1**, will show at a glance what the dissection is. The visceral mass is here somewhat too large for the size of the animal as a whole.

FIG. 9. The anterior portion of the piece cut from the dorsal wall of the branchial sac seen from the inner surface (see Fig. 3, Pl. **2**).

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows: —

- H. AUGENER. The Annelids of the "Blake."
- C. HARTLAUB. The Comatulae of the "Blake," with 15 Plates.
- H. LUDWIG. The Genus Pentacrinus.
- A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
- A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

- LOUIS CABOT. Immature State of the Odonata, Part IV.
- E. L. MARK. Studies on Lepidosteus, continued.
- " On Arachnactis.
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- M. P. A. TRAUSTEDT. The Salpidae and Doliolidae.
- H. B. WARD. The Sipunculids.
- W. McM. WOODWORTH. The Annelids.

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OF THE

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AT HARVARD COLLEGE.

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Vols. XLIII., XLVI., XLVIII., XLIX., and L. of the BULLETIN, and Vols. XXV., XXVI., XXVII., XXX., XXXIII., XXXIV., and XXXV. of the MEMOIRS, are now in course of publication.

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Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, in charge of Professor N. S. Shaler.

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Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. XLVI. No. 14.

CERTAIN SCOPELIDS IN THE COLLECTION OF THE MUSEUM OF COMPARATIVE ZOÖLOGY.

By Charles H. Gilbert.

With Three Plates.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

April, 1906.

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A. AGASSIZ. V.[5] General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
F. E. BEDDARD. The Earthworms.
H. B. BIGELOW. The Medusae.
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PRINTED FOR THE MUSEUM.

April, 1906.

No. 14. — *Certain Scopelids in the Collection of the Museum of Comparative Zoölogy.* By Charles H. Gilbert.

For the privilege of examining the Scopelids of the Museum of Comparative Zoölogy and of reporting on the species which form the basis of the following descriptions, I am indebted to the authorities of the Museum and especially to Mr. Samuel Garman.

Diaphus nocturnus (Poey).

Plate 1.

Myctophum nocturnum Poey, Mem. Hist. Nat. de Cuba, 1860, **2**, p. 426.

Collettia nocturna Jordan and Evermann, Fishes North America, 1896, **1**, p. 567.

Lampanyctus lacerta Goode and Bean, Oceanic Ichthyology, 1896, p. 81, pl. 24, fig. 89.

Myctophum (*Nyctophus*) *lacerta* Brauer, Zool. Anz., 1904, **28**, p. 392.

The species described by Poey as *Myctophum nocturnum* from Havana, Cuba, has not been identified by subsequent writers. Nothing has been certainly known of its characters and relationships except what can be drawn from the original description, and the latter unfortunately contains no account of the number and distribution of the photophores. By Jordan and Evermann, the species is placed provisionally in Collettia (= *Diaphus*), these authors remarking: "Probably a species of Collettia, and apparently related to *C. rafinesquei*, but this is not certain." As Brauer makes no mention of the species in his review of the genus Myctophum, apparently he has considered its affinities too uncertain for conjecture.

Among the Myctophids of the Museum of Comparative Zoölogy, are two lots received from Professor Poey and labeled *M. nocturnum*, apparently in Poey's own handwriting. They represent two very distinct species, for one of which, as it is apparently undescribed, the name *Diaphus garmani* is here proposed. The four specimens (No. 6873), constituting the type and cotypes, differ to such an extent from

Poey's description, that identification with *M. nocturnum* would be highly improbable. The other lot (No. 6871) consists of a single specimen which answers Poey's description closely and is here identified as the type of *M. nocturnum.* This conclusion is rendered the more probable as Poey is known to have sent many of his types to the Museum of Comparative Zoölogy. The specimen in hand is 69 mm. long to the base of the caudal fin, and must have been between 85 and 90 mm. in entire length. Poey's type is said to be 95 mm. long, but this discrepancy cannot be considered serious in view of Poey's known inaccuracy in details, consequent in part upon the fact that his descriptions were taken more or less from his drawings, instead of from the type specimens, as was indeed done in the case of *M. nocturnum.*

The type of *Diaphus nocturnus* has been compared directly with the type of *Lampanyctus lacerta* Goode and Bean, and the two found identical. *D. lacerta* was described from the Gulf of Mexico, and is well known from the Gulf Stream off the Eastern Coast of the United States. Other Myctophids from the Gulf Stream were also known to Poey, although he failed to describe them. Specimens of *Myctophum opalinum* and *M. remigerum* were collected by him at Havana and sent to the United States National Museum, where they still bear his manuscript names. As the latter have never appeared in print, it will be best not to give them currency.

Below is given a detailed description of *Diaphus nocturnus,* drawn from the type specimen:

Measurements in hundredths of length to base of caudal. Length of head 30.5; diameter of orbit, 9; length of snout, 5; length of maxillary, 22; greatest depth of body, 21; least depth of tail, 9; distance from tip of snout to front of dorsal, 50; to ventrals, 46; to front of anal, 65; to adipose fin, 81.

Dorsal with 14 rays, including all rudiments: anal, 15; ventrals with 8 fully developed rays and a short outer rudiment; pectorals, 12. Scales in lateral line, 38.

Head more compressed, the snout less blunt than in most species of this genus. Mouth large, oblique, maxillary very little widened posteriorly, its tip reaching posterior angle of cheeks. Posterior preopercular margin oblique. Inner teeth in jaws longer than the outer teeth; vomer toothless, the palatines and pterygoids provided with wide bands which cover the greater part of the roof of the mouth; tongue and basibranchials toothed. Gill-rakers of moderate length, strongly toothed, 6 + 1 + 13 in number on the outer arch.

Origin of the dorsal fin slightly in advance of the ventrals; origin of anal well behind last dorsal ray; adipose dorsal above last anal rays; both pectorals and ventrals broken so their length cannot be made out. Scales all fallen.

Distribution of photophores. — A minute round antorbital under the anterior margin of the orbital expansion of the frontal. A somewhat larger suborbital below the anterior portion of the orbit, round and surrounded by black pigment, rather smaller than the photophores on the body.

Suprapectoral near lateral line, but not in contact with it; the usual white glandular body is attached to it below. Upper infrapectoral in front of lower pectoral rays; the lower infrapectoral rather less than halfway from the upper to the first thoracic.

Thoracics, 5, the fourth elevated, but little behind the third, on a level with upper half of pectoral base; fifth thoracic in front of outer half of ventral base, the first, second, and third near the median line, forming two lines gently diverging backwards. The first thoracic interspace is nearly twice the second, which is a little longer than the fourth.

Supraventral a little nearer base of ventral fin than lateral line, vertically above middle of ventral base.

Ventral photophores, 5, the first three pairs forming two strongly diverging lines, the fourth and fifth pairs near the median line, the interspaces all about equal.

Supra-anals angulated, the upper in contact with the lateral line, a little in advance of anal fin; the middle spot below and slightly behind the upper, its distance from the upper nearly twice its distance from the lower, the lower halfway between the middle supra-anal and the fifth ventral.

Antero-anals, 7, the first pair nearest the anal base, the first six pairs forming two very gently diverging straight lines, the seventh a very little elevated above the line of the others, all of them equally spaced.

Posterolateral in contact with lateral line, over the middle of the space between the two anal groups, above or nearly above the last anal ray.

Postero-anals, 5, about equally separated from antero-anals and from precaudals.

Precaudals, 4, the first three close together and equally spaced forming a gentle curve at base of rudimentary caudal rays, the fourth more widely separated, near lateral line, but not in contact with it.

In the figure of *Lampanyctus lacerta* given by Goode and Bean (*loc. cit.*) the relative position of the ventral photophores is incorrectly shown; the last antero-anal should be a little elevated instead of in line with the others, and the fourth precaudal should be more widely separated from the third. In addition to the minute antorbital spot, present in the type of *D. nocturnus* and in all specimens of the species which have come under my observation, there develops in connection with it in some specimens a larger luminous body, which does not, however, extend far out on the snout. The black septum across the photophores is less developed in this species than in any other of the genus, being very slender, and usually incomplete in the middle.

Diaphus garmani, sp. nov.

Plate 2.

Type. — Coll. Museum of Comparative Zoölogy, No. 6873, Cuba, Dr. Felipe Poey.

Most nearly related to *D. splendidus* Brauer (Zool. Anz., 1904, **28**, pp. 392 and 399, fig. 7), differing in the greater depth, the more highly arched head and snout, and in the entirely separate antorbital photophores, the upper a minute round dot above the nostrils, the lower oblong or ovate. The supraventrals are also lower, scarcely nearer the lateral line than the ventral fins.

Measurements in hundredths of total length to base of caudal: Length of head, 27; diameter of eye, 7.5; length of snout, 5; greatest depth of head, 22; length of maxillary, 20; depth at front of dorsal, 24; least depth of caudal peduncle, 10; distance from snout to front of dorsal, 42; to ventrals, 43; to front of anal, 62; to adipose fin, 81. Length of type 51 mm.

Dorsal with 14 rays, including all rudiments, the last ray forked to the base; anal, 15; pectoral, 12; ventral with 8 developed rays and an outer slender rudiment. Lateral line, 34.

Head high and compressed, the upper profile forming a high even curve from snout to occiput. Eye small, the orbit low, the interorbital area arching high above the orbit when the head is seen in profile. Cheeks produced backwards, the margin of preopercle oblique, the maxillary reaching its angle.

Vomer toothless; palatines and pterygoids with broad bands of minute teeth which cover the greater part of the roof of the mouth; similar teeth on the tongue and basibranchials. Gill-rakers slender, 7 + 1 + 14 on the outer arch.

Origin of dorsal over or slightly in advance of the ventrals; origin of anal under last dorsal ray; adipose dorsal inserted over last anal ray.

Scales of lateral line a little enlarged; three series of scales between lateral line and base of dorsal fin.

General color dark brown, or blackish, with bright reflections from the scales. Basal portions of vertical fins finely speckled with black.

Photophores. — A minute dorsal antorbital under the anterior edge of the supraorbital rim; a larger ventral antorbital is wholly detached from it and extends but little below the anterior part of the orbit.

Suprapectoral above opercular angle, slightly nearer lateral line than base of pectoral, without attached luminous gland. Upper infrapectoral in front of lower pectoral rays; lower infrapectoral halfway between upper and first thoracic.

Thoracics, 5, the fourth elevated, a little behind the vertical from the third, the fifth in front of outer ventral rays. First thoracic interspace longest, the second and fourth about equal.

Supraventral over the posterior half of ventral base, midway between lateral line and ventral fin.

Ventral photophores, 5, the first three pairs forming strongly diverging lines, the first interspace a little shorter than the second, the third pair a little in advance of the vertical from the fourth; fourth and fifth pairs near median line, as usual.

Supra-anals not angulated, or with the middle very slightly in advance of a line joining the other two, the upper in contact with the lateral line; lower interspace much shorter than upper.

Antero-anals, 7, the first elevated above and a little anterior to the second; the second to the sixth nearly parallel with anal base, the seventh again elevated, but less so than the first, inserted well behind a line joining sixth with posterolateral.

Posterolateral in contact with the lateral line, but little behind seventh antero-anal, well in advance of last anal ray.

Postero-anals, 5. Precaudals, 4, the first three evenly spaced, forming a curve, the fourth more distant, but little below lateral line.

Three cotypes from the same locality show no variation in the number and distribution of the photophores.

The species is named for Mr. Samuel Garman of the Museum of Comparative Zoölogy.

Myctophum pristilepis (Gilbert and Cramer).

Plate 3.

Dasyscopelus pristilepis Gilbert and Cramer, Proc. U. S. Nat. Mus., 1897, **19**, p. 412, pl. 39, fig. 1. Gilbert, Bull. U. S. Fish Com., 1905, **23**, pt. 2, p. 600.

A specimen, 75 mm. long, collected near the Island of Mauritius by Mr. Nicholas Pike, extends the range of this species from the Hawaiian Islands to the western shores of the Indian Ocean.

The specimen is somewhat larger than those hitherto reported and exhibits the noticeable increase in the size of the eye which in this group accompanies growth. A specimen from the Hawaiian Islands 30 mm. long to base of caudal has the eye 12 hundredths of this length; another from the same locality 52 mm. long has the eye 13 hundredths; in the Mauritian specimen 67 mm. long to base of caudal the eye is 13.5 hundredths. In smaller examples, the diameter of the eye is less than the postocular length of the head; in adults, it exceeds the postocular length and is 48 hundredths of the total length of the head.

In the young of this species, the scales have entire margins, a specimen 35 mm. long showing no trace of marginal spines on the scales of the lateral line and on such others as are present. In the Mauritian

specimen, the scales of the lateral line are entire or very weakly armed except in the middle where they are not concealed by the overlapping scales, but other scales of the body bear short strong spines.

The anal photophores are 7 + 4, the number most frequent in this species. The two precaudals are near lower edge of caudal peduncle, not more widely separated than the postero-anals, but somewhat obliquely placed, the second a little higher than the first. The supra-anals form an oblique line, very weakly angulated, the lower very slightly in advance of the line joining the other two, the lower interspace about half the upper. A minute antorbital photophore in its usual dorsal position under the anterior frontal rim is evident in the young, but becomes obscure and apparently functionless in adults. A larger antorbital photophore persists at lower anterior orbital margin, well below the nostrils. The Mauritian specimen is a male with well developed supracaudal luminous organ, consisting of four shining scales which overlap little or not at all.

The species differs from *M. asperum* Richardson, according to the original description and figure (Voyage "Erebus" and "Terror," Ichth., p. 41, pl. 27, figs. 13, 15), in the larger eye, shorter snout, the fewer anal photophores, and in the relative position of the supra-anals and the precaudals, the former being strongly angulated and the latter widely separated in *M. asperum*. The relation of *M. pristilepis* with *M. opalinum* Goode and Bean is much closer. The two agree in general outlines and proportions, and in the arrangement of the photophores. In *M. opalinum*, the scales also are rough, a character which hitherto has not been noticed, and which separates *M. opalinum* widely from *M. affine*, with which Brauer unites it. This statement is based on an examination of the types of *M. opalinum* in the United States National Museum. *M. opalinum* has a much smaller eye and a somewhat longer snout than *M. pristilepis*, and more numerous anal photophores, which vary from 8 + 5 to 9 + 6. Even the lowest number known in *M. opalinum* is thus beyond the known range of *M. pristilepis*, which is from 6 + 4 and 7 + 3 to 7 + 5 and 8 + 4. In all the respects in which *M. opalinum* is known to differ from *M. pristilepis*, it approaches *M. asperum*.

Myctophum humboldti (Risso).

A specimen (No. 6870, M. C. Z.) collected by D. D. Roulet, "on a voyage from China" answers sufficiently well to the current descriptions of this Mediterranean species, but these descriptions are so lacking in detail that the identification cannot be considered reliable. Nor is it

possible to determine its relationships to *Myctophum boops* Richardson, from the Pacific Ocean, a species which has usually been considered identical with *M. humboldti*, but apparently without direct comparison. In spite of the doubtful locality of the specimen in hand, it seems advisable to place on record a more detailed account of its characters. It differs from typical *M. humboldti* in having on each side 8 + 6, instead of 8 + 8 anal photophores, but the variation in *M. humboldti* may well include this formula. It must be considered very doubtful, however, whether any species will include all the variations which have been attributed to *M. humboldti*.

Measurements in hundredths of length without caudal (107 mm.): Length of head, 26.5; diameter of eye, 9; length of snout, 4.5; length of maxillary, 16.5; interorbital width, 8; depth of body, 21; least depth of tail, 7; distance from snout to dorsal, 43; to adipose fin, 78; to ventrals, 45; to anal, 62.

Dorsal with 12 rays, including all rudiments; anal, 20; pectoral, 14; ventral with 8 fully developed rays and no evident rudiment. Lateral line, 41. Gill-rakers, 6 + 1 + 16, on outer arch.

The scales are mostly lost, but a few along the course of the lateral line indicate that these are much deeper than the others.

The ventrals are inserted under the front of the dorsal; the anal fin is entirely behind the dorsal; the adipose fin is well in advance of the last anal ray. The fins are all broken, so no indication can be given of the length of the rays.

The mouth and gill cavity are black, this color including the gill-arches and the gill-rakers, but not the gill-filaments or the pseudobranchiae.

Photophores. — A small dorsal antorbital organ, obscure in this specimen; a more evident lower antorbital, which seems to be persistent in adults.

Suprapectoral distinctly nearer upper pectoral rays than lateral line. Upper infrapectoral on base of lower pectoral rays and below; lower infrapectoral somewhat below the line joining the upper with the first thoracic, its distance from the former less than two-thirds its distance from the latter; the vertical from the lower infrapectoral passes immediately before the second thoracic. Upper pectoral interspace slightly longer than the lower.

Thoracic photophores peculiar in having the first three pairs forming rather widely diverging lines, the fourth pair less widely separated, about as in the second pair, the fifth pair very widely divergent, opposite and partly external to the outer ventral rays; second and fourth interspaces equal, the third shorter, two-thirds the first.

Supraventrals vertically above the fifth thoracic, a little nearer the latter than the lateral line, distinctly above the line of the two lower supra-anals.

First pair of ventral photophores nearer median line than are the inner ventral rays, which are unusually far apart; first three pairs of ventrals form-

ing diverging lines, the fourth again less widely separated; fourth pair wholly in advance of vent. First ventral interspace longer than the second, the third the shortest.

Upper supra-anal just below the lateral line, vertically above vent or a little anterior; middle supra-anal vertically above fourth ventral, or a trifle anterior; lower supra-anal in advance of and slightly below the middle supra-anal, nearly over the second ventral. Upper supra-anal interspace less than two-thirds the lower.

Antero-anals, 8, forming a strongly curved line, the concavity downwards; first pair very closely approximating anal base, second and third widely diverging, the others again gradually approaching the anal base; last antero-anal opposite base of the fourteenth anal ray.

Posterolateral vertically above last antero-anal, immediately below lateral line.

Postero-anals, 6, the first opposite the base of the seventeenth anal ray; interval between last anal and first precaudal equalling that between first and fifth postero-anals.

Precaudals, 2, obliquely placed, the distance between them only slightly greater than that separating the postero-anals.

A short luminous body on back of tail, less than half as long as diameter of eye, with no trace of overlapping scales in the present condition of the specimen.

EXPLANATION OF PLATES.

PLATE 1.

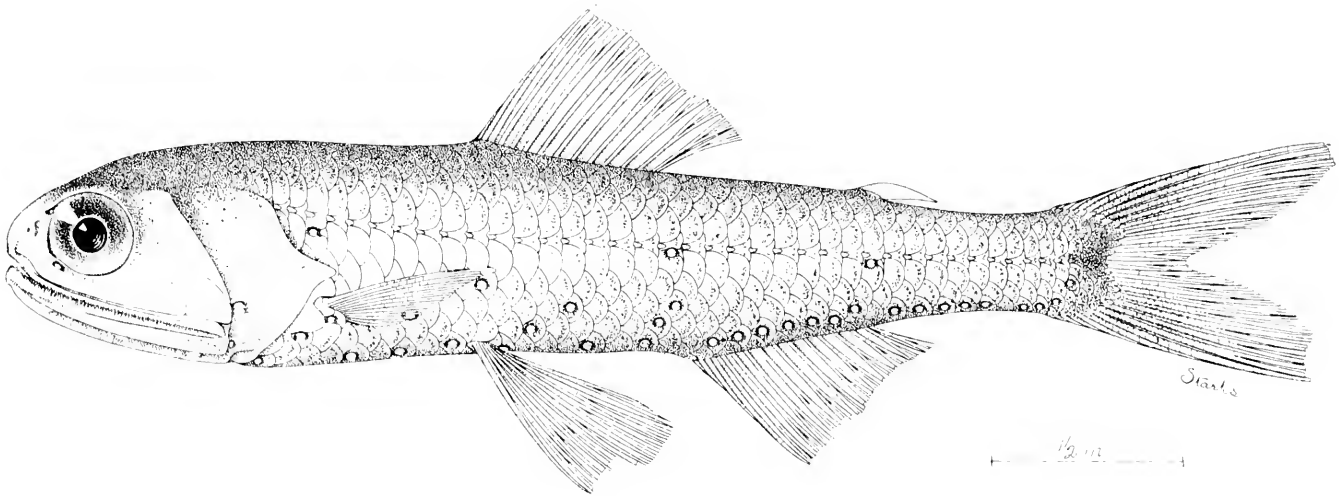
Diaphus nocturnus (Poey).

PLATE 2.

Diaphus garmani Gilbert.

PLATE 3.

Myctophum pristilepis (Gilbert & Cramer).



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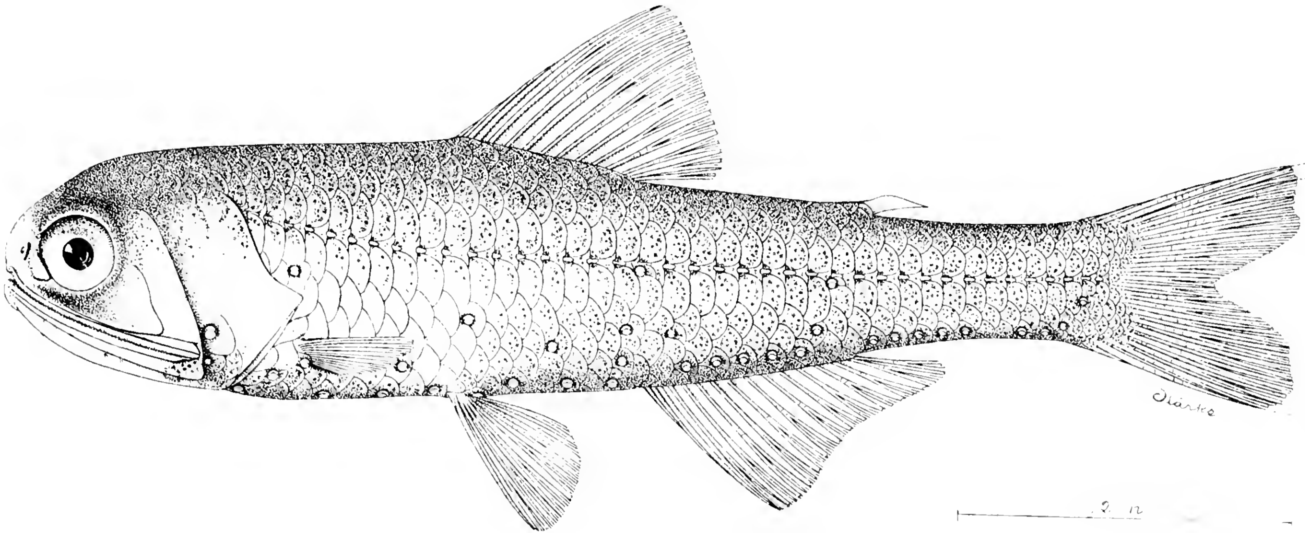

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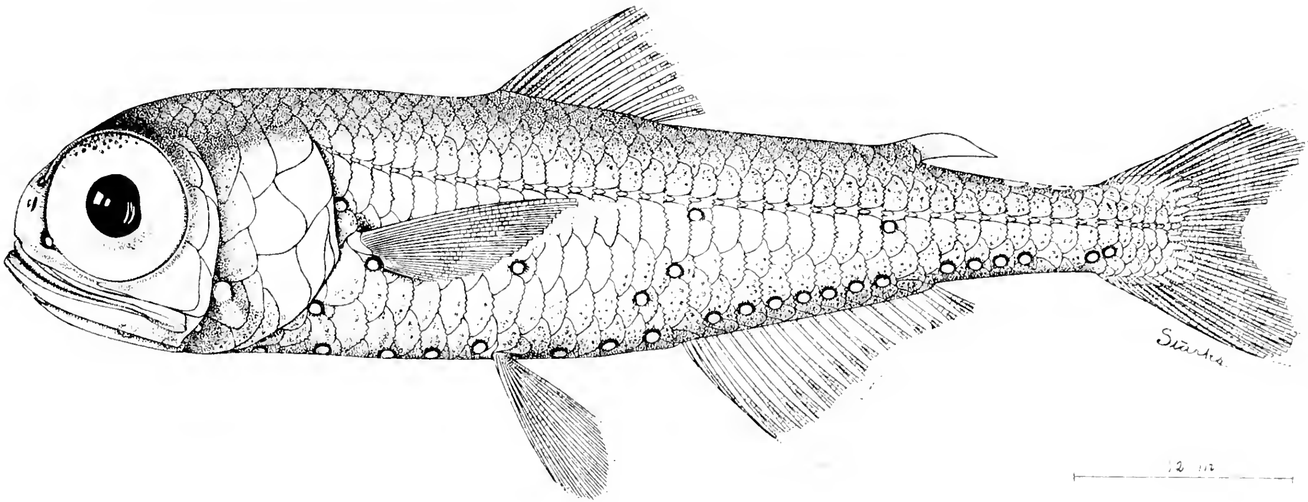

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